Columbia University
in the City of New York

LAMONT GEOLOGICAL OBSERVATORY
PALISADES, NEW YORK

# Technical Report No.7

CU-15-55-N6 onr 27124 Geol.

# Precision Depth Recorder MK IV-A

March 1955

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(COLUMBIA UNIVERSITY)
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# PRECISION DEPTH RECORDER MK IV-A

by

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The work described in this document was performed under the sponsorship of the United States Navy under contracts N6-onr-271 T. O. 24 with the Office of Naval Research and NObsr 64547 with the Bureau of Ships. This publication is for technical information only and does not represent recommendations or conslusions of the sponsoring agencies.

MARCH 1955

## FOREWORD

This report consists of an instruction manual prepared by the authors for use with the Precision Depth Recorder MK IV-A equipment. The manual was written to accompany several of these equipments built for the Western Electric Company under Contract XFE-45834. In response to many queries, this manual is here published as a technical report to provide detailed technical information to those individuals and organizations interested in building precise depth recording systems.

The design of the equipment is based on principles of expediency. Every effort was made to use commercially available equipment where possible and limit the construction to the necessary interconnecting and control apparatus. It will be obvious to those who study the design with the intent of building an apparatus that a great deal of duplication and complication may be avoided.

## ACKNOWLEDGMENTS

The development of precision depth recording equipment is a continuing project of the Lamont Geological Observatory. Professor Maurice Ewing, Director of the Observatory exercises general supervision of the project and has contributed many of the basic design specifications.

The major portion of the construction was undertaken with the aid of the authors' associates at the Columbia University Geophysical Field Station in Bermuda.

. The authors are also greatly indebted to the Times Facsimile Corporation for invaluable cooperation.

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| Reference | Title |
|---|---|
| A | NAVSHIPS 91630 - Instruction Book for Facsimile Recorder RD-92A/UX with RJC Modifications. |
| B | "Precision Measurement of Ocean Depth" Luskin, Heezen, Ewing and Landisman DEEP SEA RESEARCH Vol. I No. 3 |
| C | NAVSHIPS 91420 Instruction Book for Sonar Sounding Set AN/UQN-1B |

# SECTION I - GENERAL DESCRIPTION

## 1. INTRODUCTION

This instruction book covers the essential information for installation, operation and maintenance of the Precision Depth Recorder MK IV-A. This equipment was conceived, designed, developed and constructed by members of the staff of the Lamont Geological Observatory of Columbia University. It is a simplified version of the PDR MK IV which is installed on the Research Vessel VEMA, the University's oceanographic research ship. The equipment is designed and constructed so that the features of the MK IV equipment lacking in the MK IV-A may be added with relatively little construction.

The Facsimile Chart Recorder, Model RJ-C, was manufacured by the Times Facsimile Corporation and modified according to specifications supplied by the Observatory staff. This recorder is a new type - previous models of the PDR (MK I, II and III) used drum recorders. The mechanical unit of the Chart recorder is, of course, quite different from the drum recorders. However, the electronics chassis, except for a few minor modifications, is entirely similar to the one supplied with the drum recorders (Facsimile Recorder RD-92A/UX). The MK IV equipment includes a drum recorder of this type as well as a chart recorder. The drum record provides a compressed scale record to complement the expanded scale record of the chart recorder.

## 2. PURPOSE AND BASIC PRINCIPLES

a. Purpose - A sonic sounding system is used to obtain nearly continuous records of ocean depth. The PDR equipment is used to supplant the recorder unit of conventional Sonar sounding equipment. The PDR provides a sounding record with a scale expansion and an accuracy completely beyond the capabilities of conventional sounding equipments.

The scale of the MK IV-A equipment is 18.85 inches equals 400 fathoms or about 1 mm. equals 1 fm.; and the estimated accuracy is at least 1 part in 3000 exclusive of uncertainties in the average vertical velocity of sound. Thus, the record gives a reliable picture of the sea bottom in fine detail. The equipment will operate in any depth of water, being limited only by the power capabilities and signal/noise ratio of the sonar sounding set installation.

b. Basic Principles - A sonic sounding system consists of transducer, transmitter, receiver and recorder. The transducer converts electrical energy supplied by the transmitter into sound energy which propagates through the sea water and is reflected from the bottom. The reflected sound energy is then converted into electrical energy by the transducer and supplied to the receiver. The receiver feeds the electrical energy of both the outgoing and reflected pulses (pings) into the recorder. The function of the recorder is to time the interval between the transmission and reception of the pings and display the time difference information so that it may be easily converted into depth information. The latter conversion presumes a knowledge of the average vertical velocity of sound.

The Precision Depth Recorder performs only the recording function. It is intended to be coupled to the transducer, transmitter and receiver of a conventional deep water echo sounder such as the Sonar Sounding Set AN/UQN-1B or NMC-1 in place of the recorder units ordinarily supplied with these equipments. The PDR performs the timing function, under ordinary operating conditions, to better than 1 part in 1,000,000. It displays the timing information on a highly expanded scale so that the fine detail of the bottom is recorded. This high precision is made possible by the tuning-form-controlled, slip-free drive of the Facsimile Recorder. Assuming 1 mm. to be the smallest readable unit, the uncorrected depth, as read from the record is good to ± 1 fathom. (Conventional echo-sounding practice uses a standard velocity of sound of 800 fathoms/second to convert time measurements into depth. This is referred to here as the uncorrected depth).

Under favorable operating conditions, the operation of the recorder system is simple. One ping is transmitted every second and one ping is received every second. This is referred to here as High Density Recording (HDR). It is not always possible to operate in this manner because the recording of the outgoing ping and reverberation uses up the available dynamic range of a portion of the recording paper which may include the record of the echo. Also, recording of the scattering layer, especially under noisy conditions, eliminates a portion of the useful recording area. This is especially true for weak echo operation - as in deep water, or if the bottom reflectivity is poor, or if the Sonar Set is not operating at maximum efficiency. For these operating conditions, a gating cycle system is included in the equipment. The input to the recorder is gated on a program arranged to allow only one of the group of outgoing

pings to be recorded for base line purposes. It is arranged also to allow a maximum density of echo pings and a minimum density of noise to be recorded.

For survey purposes ocean depth information is useful only if coordinated with geographical position. Since usual navigation procedure relates geographical position with time (of day), it is practical to display the depth information as a function of time. Precision 60 cycle per second voltage is obtained from the synchronous drive mechanism of the Facsimile Recorder which, when amplified, is available to drive electric clocks and a cam-switch mechanism which provides time marks on the record. When the tuning-form is properly adjusted, the accumulated time error, checked against WWV, of an ordinary electric clock operating from the precision source should be less than 1 second per month.

The vertical exaggeration of the PDR sounding record is a function of ship's speed and the paper traverse speed only, since the record scale is fixed at 400 fathoms. The most desirable vertical exaggeration depends on the topography of the ocean bottom. Three traverse speeds are available in the MK IV-A equipment, 6, 24 and 96 inches per hour. If we assume a 3:1 ratio of operating speeds for a 15 knot ship, a vertical exaggeration of 2.5:1 is available for the steepest topography and one of 118:1 is available for flat bottom.

The sounding record does not resolve the ambiguity of the base line, which may represent any multiple of 400 fathoms. In the MK IV equipment, the Slow Drum record which has a scale of 2400 fathoms, readily provides this information. However, the operator of the MK IV-A equipment has several methods available to him of determining the base line. (SEC. IV-2).

c. General Description - The PDR MK IV-A consists of two units: (1) Chart Recorder: (2) Control Rack.

(1) The Chart Recorder is a modified Times Facsimile Recorder Model RJ-C. It consists of an electronic chassis and a mechanical unit. The electronic chassis is a slightly modified version of the one described in NAVSHIPS 91630, Reference A. The mechanical unit is a new type for

which no instruction manual is available. It is a continuous web-type recorder feeding paper from a 350 foot roll. The 3 styli are mounted on a belt mechanism which is driven by an induction motor and restrained by a synchronous motor of the phonic type. The principles and specifications of the driving system are identicalto those of the RD-92A/UX which has a driven record and a traversing stylus. The mechanical unit also contains a contact assembly which provides the various triggers for gating and keying the Sonar signal, a generator which provides precise 60 cps voltage, and a 20 cps generator to provide 20 fathom marks on the record.

(2) The Control Rack consists of a Control Unit and a Precision AC Supply Unit, mounted in an open desk-type rack. The control unit consists of a Power Supply chassis, a Counter Chassis, a Control Chassis and a Signal Chassis. The Precision AC Supply Unit includes a 30 watt power amplifier, an electric clock, a voltmeter, a Time-Mark Chassis and a Precision AC Loading Chassis.

The complete PDR, including the cabling is shown in Figures 1 and 2. The contact assembly is shown in Figure 3 and the various arrangements of the traverse gears in Figures 4, 5 and 6.

d. Applications.

The PDR MK IV-A is used for recording sonic soundings in place of the recorder units supplied with conventional sounding gear. It is intended for use in deep water surveys where high precision and fine details of relief are required.

For further information on the background and applications of PDR equipment, see Reference B.

## SECTION II - THEORY OF OPERATION

### 1. INTRODUCTION

The Precision Depth Recorder is a precise timing device which displays the time difference between transmitted and bottom-reflected sonic pulses on an expanded scale. The correlation of this displayed information with ocean bottom topography depends upon many factors beyond the scope of this manual. For present purposes, it is considered that the record obtained is a representation of the ocean bottom and gives the depth in fathoms.

a. Sonar Sounding Set - The Sonar Sounding Set is the basic equipment for recording depth. The PDR is intended to replace the recorder unit of conventional sounders which do not provide the expanded scale and high precision required for detailed surveys. Hereafter, the Sounding Set referred to will be the Sonar Sounding Set AN/UQN-1B. Complete information on this equipment is contained in Reference C.

This equipment may be considered to consist of a transducer, transmitter and receiver. The transmitter energizes the transducer when it is keyed by a grounding contact. The receiver passes and amplifies both the transmitted pulse and the bottom-reflected pulses. The output of the receiver is available at a high-level low-impedance outlet.

b. Recorder - The Recorder Unit has two main functions: (1) to provide a display of the sonic pulse time-difference information in a precise and integrated manner; (2) to provide a keying contact for the Sonar transmitter. It also has several auxiliary functions: (1) to provide a precision 60 cps signal voltage; (2) to provide precise 20 cps pulses; (3) to provide keying contacts for the Control Rack counters; one contact making once per second and another contact making once every 6 seconds.

c. Control Rack - The Control Rack provides the link between the Sounding Set and Recorder and has several auxiliary functions. The Control Unit in the upper part of the rack contains the circuits for linking the Sounding Set and Recorder. The Amplifier, Loading and Time Mark Units, in the lower part of the rack, supply the auxiliary functions.

(1) Control Functions

The Control Unit has only one control - the 5-position Master Selector Switch mounted in the center of the panel (see Fig. 10). Each switch position corresponds to a different mode of operation of the PDR equipment.

The first step, labelled HDR, corresponds to a simple connection between Sounder and Recorder; the keying leads of the sounder transmitter are connected directly to the keying contact of the Recorder; the receiver output is connected directly to the recorder input. One ping is sent out and one received every second. The next four switch steps correspond to 4 different operation programs. Each program is most suitable for the depth range with which it is labelled. In these 4 modes of operation the keying and signal connections between Recorder and Sounder are gated in a coordinated program cycle. Each cycle is arranged to provide a maximum sampling and signal/noise ratio for the appropriate depth range. The ranges are selected for maximum simplicity of operation.

The programming operation may be divided into 4 parts:

A. Counting the traverses of the styli. This is done by the counter trigger contacts in the Recorder. One contact makes once per second soon after a traverse starts. This counts traverses, seconds, or 400 fathom units, all of which are equivalent. One contact makes once every 6 seconds in synchronism with the first contact. This counts traverses in sixes, 6 second time intervals, or 2400 fathom units, all of which are equivalent. The first contact triggers the depth counter, the second triggers the reset counter.

B. Storing the count information. This is done by the counters in the Control Rack. The depth counter stores one-second counts, the reset counter six-second counts. The operation of the counters is equivalent to moving the swinger of a selector switch, energized with B-voltage, to successive positions, one move being made for each trigger pulse. The functions performed by the counters are identical to those of the rotary stepping relays commonly used in telephone circuits.

C. Setting up the cycle. This is done by the Master Selector Switch on the front panel of the Control Unit. The switch connects the gating relay coils to the count points on the counters appropriate to the depth range of operation. Three gates are controlled by the switch; the transmitting gate, the receiving gate and the reset gate.

D. Gating. The transmitting and receiving gates are single-pole double-throw relays operated in flip-flop fashion by 2 coils. Pulsing one of the coils causes the swinger to throw and remain in the thrown position. Pulsing the second coil throws the swinger back to its original position. The transmitting gate connects the Sounder keying lead to the Recorder keying contact in the "Gate Open" position, and leaves it open-circuited in the "Gate Closed" position. The receiving gate connects the Recorder input to the Sounder signal output when the gate is open, and grounds the input when the gate is closed. The reset gate is a single-pole double-throw relay of the conventional type. It causes the reset coils of the depth and reset counters to be energized and thus end the gating cycle. The coil of this relay is shunted by a condenser in order to increase its drop-out time enough to cover the counter resetting time.

Figure 7 is a simplified schematic diagram of the transmitting gate circuit. In HDR position, the opening coil of the gate is constantly energized while the closing coil is disconnected. In this position, then, the gate is always open and the keying contact in the Recorder will key the Sounder once per second. In all the other positions, the gate will open when the counters are reset or on count O. In the 0-2000 and 1600-3200 fathom ranges the gate will close on count 5, allowing 5 pings per cycle to be transmitted. In the 2800-4400 fathom range 8 pings are transmitted; in the 3600-6000 fathom range 10 pings are transmitted per cycle.

Figure 8 is a simplified schematic diagram of the receiving gate circuit. In HDR position, the opening coil of the gate is constantly energized while the closing coil is disconnected. In this position, the gate is always open and the Sonar signal is always

connected to the Recorder input. In the 0-2000 fathom range the gate is also always open. The difference between this mode of operation and HDR lies in the fact that the record of the echo pings is displaced with respect to the record of the transmitted pings. In 1600-2000 fathoms of depth, 4 of the echos will be displaced with respect to the transmitted pings: in 1200-1600, 3 will be displaced, etc. Only in 0-400 fathoms can the bottom record be fully superimposed on that of the transmitted pings. However, in the range 0-1200 fathoms the echo is usually strong enough not to be masked by the reverberation of scattering layer signals. Also, the topography in this depth range is usually steep enough so that the outgoing ping line does not interfere with the bottom record. In the other 3 switch positions, the gate is closed when the counters are reset - count 0 and opens just in time to record the last of the transmitted pings. In the 1600-3200 fathom range, the gate opens on count 4, which occurs before the 5th. and last ping transmitted in this position. Similarly, in the 2800-4400 fathom range, the gate opens on count 7 to record the 8th. ping; in the 3600-6000 fathom range, the gate opens on count 9 to record the 10th. ping.

Figure 9 is a composite plan of the entire gating cycle program. Note that in the HDR position the counter circuits are inoperative so that there is no cycling.

In the 0-2000 and 1600-3200 fathom ranges the cycle is 12 seconds long. It is 18 seconds long in the 2800-4400 fathom range and 24 seconds in the 3600-6000 fathom range. The reset cycle is determined from the reset counter information. The 3 lengths of the cycle correspond to counts 2, 3 and 4, respectively, of this counter.

The density of sampling is 60 pings per minute in HDR; 25 pings per minute in the 0-2000, 1600-3200 and 3600-6000 fathom ranges, and 26 2/3 p. p. m. in the 2800-4400 fathom range.

As an illustration of the considerations involved in planning the cycles, consider the 1600-3200 fathom range. Five pings are transmitted

every 12 seconds and the Recorder prints for 8 out of the 12 seconds. Only one of the 8 recording traverses will include the record of the transmitted ping and its reverberation. Echoes from reflectors at depths less than 1600 fathoms will not be recorded. Five of the 8 recording traverses will include the record of the bottom. Note that if the actual depth is between 2800-and 3200 fathoms, the last of the outgoing pings is not recorded. This situation also exists in the other ranges at the extremities. This loss of wanted signal can be remedied by shifting to the next range in all cases but the 3600-6000 fathom range. However, in this case, the loss amounts to but 10% and the density of sampling is still adequate. In the 6000 fathom range on the AN/UQN-1B, for example, the density of sampling is 2 pings per minute.

(2) Auxiliary Functions.

The auxiliary functions of the PDR equipment are: (1) to provide precision 60 cycle AC power for time-keeping purposes; (2) to provide 20 cps pulses for 20 fathom marks on the depth record.

The prime source of precision 60 cycle voltage is the pickup coil and cam assembly in the Recorder (behind 30 RPS wheel in Figure 3). The cam is rotated by the synchronous motor shaft at a precise rate of 1800 rpm. The voltage induced in the coil assembly is then amplified by the Power Amplifier in the Control Rack. This makes available 30 watts of precision 60 cycle power at 115 volts. About 5 watts of this power is used to run the clock on the front panel of the Precision AC unit, (Fig. 11) and the 1/5 RPM motor in the Time Mark Chassis.

The source of the precision 20 cps pulses in another pickup coil and cam assembly in the Recorder operated by the synchronous drive system of the Recorder (see Fig. 3). These pulses are recorded as evenly-spaced lines on the chart which correspond to 20 fathom divisions. The pulses are interrupted for a short time every 5 minutes by the motor-driven switch in the Time-Mark Chassis, thus providing precise 5-minute marks on the chart record.

## 2. DESCRIPTION OF UNITS AND CIRCUITS.

a. Sonar Sounding Set - Complete information on the AN/UQN-1B Sounding Set is contained in Reference C.

b. Recorder - The Recorder is a Facsimile Recorder Model RJ-C manufactured by the Times Facsimile Corporation of New York. Essentially it is a continuous-web type facsimile recorder modified according to specifications supplied by the Lamont Geological Observatory.

The Recorder is composed of 2 main assemblies; (1) a Mechanical Unit; (2) an Electronics Unit. The Mechanical Unit is built as a plug-in unit on the Electronics Unit. The two units and a blower are mounted in one cabinet. The Recorder is illustrated in Figs; 1-6, 12. The drum-type facsimile machine described in Reference A operates on the same general mechanical principles and has almost identical electronic circuits.

(1) Mechanical Unit - The Mechanical Unit consists of the basic driving mechanism for traversing the styli and feeding the chart, a contact assembly, and 2 generator assemblies.

The driving system consists of 3 motors, a latch mechanism, and gearing. The synchronous drive system consists of a start motor which brings the phonic-type synchronous motor up to synchronous speed. The synchronous motor detains the main drive motor, a single-phase induction motor, by means of the latch mechanism. The driving system is illustrated in Figure 28. The chart feed speed is determined by the arrangement of the traverse gears. Three speeds are available 6, 24 and 96 inches/hr. The gear arrangements corresponding to the 3 speeds are shown in Figures 4, 5 and 6.

The Contact Assembly consists of a set of 3 contact wheels and 5 brush assemblies. There are three "make" contacts to ground; (1) The depth counter trigger contact makes once per second for a duration of 30-40 milleseconds; (2) The reset counter trigger contact makes once every 6 seconds, in synchronism with the depth counter trigger contact, for a duration of about 150 milleseconds; (3) The keying contact makes once per second for a duration of 1-2 milleseconds.

The arrangement of the contacts is shown in Figure 3, the three contact wheels rotate at speeds of 30 rps, 1 rps and 1/6 rps respectively. Contact (1) consists of the inside brush on the 1 rps wheel and the grounded wheel. Contact (2) consists of the brush and the grounded 1/6 rps wheel. Contact (3) consists of the 2 brushes on the 30 rps wheel, the outside brush on the 1 rps wheel, and the grounded 1 rps wheel. In this case, the 1 rps contact acts as a gate for the short duration contact made 30 times per second on the 30 rps wheel.

Note that the 1/6 rps wheel is driven by the run drive system while the other two wheels are driven by the synchronous drive system.

The Generator Assemblies are two in number; (1) the 60 cps sine wave generator; (2) The 20 cps pulse generator. These are shown in Figure 3. Both generators work on the variable reluctance principle. Two coils are wound around permanent magnet cores. The magnetic flux path is completed by the rotating cam. Due to the variation of the reluctance of the circuit, a voltage is induced in the coils whose wave shape closely approximates the physical developed shape of the cam.

(2) Electronics Unit - The Electronics Unit described in Reference A is entirely similar to the RJC type except for the following:

A. The phasing and relay circuits are omitted.
B. The phase switch is rewired to provide event marks.
C. The synchronous motor drive circuit is modified for a 2-phase motor.
D. All the connections required by the PDR equipment are brought to one 14-pin receptacle at the rear of the Electronics Unit.

The most important circuit connections are shown in Reference A. Connection is made to the Signal Chassis through P6-J6, to the Control Chassis through P4-J4, to the Time Mark Chassis through P7-J7 and to the Power Amplifier through the RCA Phono Plug. The cabling diagram is shown in Fig. 21. The Chart Recorder controls are on the front panel of the Electronics Chassis and are shown in Fig. 12.

c. Control Rack - The Control Rack consists of the following units: Power Supply, Counter Chassis, Control Chassis, Signal Chassis, Time Mark Chassis, Precision AC Power Amplifier, Precision AC Loading Chassis. The first four units are in the upper or Control Unit part of the Rack mounted on a sliding shelf. The other 3 units are in the lower or Auxiliary Unit part of the Rack.

(1) The Power Supply is a 10" x 8" x 2 1/2" cadmium plated steel Chassis mounted on the left rear of the Control Unit. Figure 13 shows the location of this unit and Figure 14 its internal construction. The Power Supply contains the circuits for supplying the counter high voltage (C+, C-), the relay high voltage (B+, B-) and the tube filament voltage (F1, F2). Connection i s made to the Control Chassis through the cable terminated by the 12-pin Cannon plug, P2.

(2) The Counter Chassis is a 5" x 9" x 6" black steel utility box mounted on the left front of the Control Unit. Figure 13 shows the location of this unit and Figure 16 its internal construction. The Counter Chassis contains 3 Kellogg Magnetic Impulse Counters, all wired identically. Connection is made to the Control Chassis through the 2 cables terminated by the 15-pin Cannon plugs, PD and PR. Any two of the counters may be used - one is a spare. The clear plastic window covering the left side of the chassis allows visual inspection of the counter operation when the Control Unit shelf is extended.

(3) The Control Chassis is a 17" x 11" x 3" black steel chassis mounted on the right side of the Control Unit. Fig. 15 shows the location of this unit and Fig. 17 its internal construction. The Control Chassis contains all the circuits for operating the gating cycle program. It contains all the gating circuit components except the receiving gate relay. Connection is made to the Power Supply through receptacle J2, to the Counter Chassis through the cables terminating in plugs PD and PR, to the Signal Chassis through receptacle J1, to the Recorder through receptacle J4, and to the Sounder through receptacle J3.

(4) The Signal Chassis is a 5" x 7" x 2" black steel chassis mounted at the right front of the Control Unit. Figure 13 shows the location of this unit and Figure 18

its internal construction. The Signal Chassis contains the circuit for connecting the Sonar Signal to the Recorder through the receiving gate. Connection is made to the Control Chassis through the cable terminating in P1, to the Sounder signal outlet through receptacle J5, and to the Recorder Signal input through receptacle J6.

The 4 units described above comprise the Control Unit. The units are all mounted on a sliding shelf which has a front panel 12 1/4" x 19". The front panel is shown in Figure 10. The Master Selector Switch controls the functions of the circuits in the Control Chassis. The signal, gated and ungated, may be monitored at the two receptacles provided. The three push-button switches are for testing the counters.

(5) The Time Mark Chassis is a 5" x 7" x 2" black steel chassis mounted at the lower right side of the Control Rack. Figure 2 shows the location of this unit and Figure 19 its internal construction. This chassis contains the motor and cam-switch mechanism which interrupts the 20-fathom marks on the chart record every 5 minutes. Connection is made to the Recorder through receptacle J7, and to the Precision AC Loading Chassis through a line cord.

(6) The Precision AC Power Amplifier is a modified Bogen Model J130. It is mounted in the central lower part of the Control Rack. Figures 1 and 2 show the location of this unit. This unit amplifies the precision 60 cps signal from the Recorder and makes it available at 115 volts and a capacity of 30 watts. The front panel of the amplifier, Figure 11, contains a clock, an AC voltmeter, and their respective switches.

The power switch and volume control are in the lower part of the panel. Connection is made to the Recorder through the Phono Input jack and to the Loading Chassis through a line cord with a female cable connector termination.

(7) The Precision AC Loading Chassis is a 5" x 7" x 2" black steel chassis mounted at the lower left side of the Control Rack. Figure 2 shows the location of this unit and figure 20 its internal construction. This unit contains 3 condensers with their connection switches for power factor correction of the precision AC load. It also contains a

10 watt lamp used as a dummy load. Connection is made to the Power Amplifier through the recessed male receptacle. Two female receptacles are available for external loads.

3. CIRCUIT ANALYSIS

a. Sonar Sounding Set - the circuits of the AN/UQN-1B sounder are described in Reference C. Only those parts of the circuit which have to do with the PDR equipment will be considered here. These are the Motor Drive, the Keying Leads and the EarPhone Output jack. See Reference C.

(1) The Motor Drive of the Sounder is connected for a separate 60 cps 115 V source as shown in Reference G, Figure 3-3. If it is desired to run the Sounder Recorder at times, the AC source for the drive motor may be switched. In any case, it is disconnected while the PDR is operating. The belt holding the recording styli is advanced until neither one of the styli is in contact with the paper.

(2) The Keying Leads are normally connected to the keying contacts, S-201 (Figure 2-9). These are disconnected and led, through a shielded cable, to the Control Chassis input J3. If it is desired to run the Sounder at times, the keying leads may also be switched.

(3) The Earphone Output Jack is used as the source of signal for the PDR. A shielded cable leads the signal from this point to the Signal Chassis input J5. Condenser C-221, 680MMF., is shunted by a 0.1 MFD, 600 V condenser.

Aside from the Circuit changes mentioned above, the Sounder is operated as usual.

b. Recorder - The circuits of the Recorder are described in References A, E and F. The cable diagram is shown in Figure 21.

NOTE: THE RECORDER B- IS ONE SIDE OF THE AC LINE. IT IS NOT THE SAME AS CHASSIS GROUND.

Refer to Figure 21. The Recorder inputs and outputs all come out at the 14-pin plug at the rear of the Electronics Unit. The interconnecting cable between the Recorder and Control Rack is

split into 4 parts - Cables going to the Signal Chassis, Control Chassis, Power Amplifier and Time Mark Chassis.

(1) The signal input is at pins F and G. It is connected by a shielded cable to the Signal Chassis through P6-J6.

(2) The contacts are connected to the Control Chassis through P4-J4. The depth counter trigger is at pin B at the Recorder and pin 2 at the Control Chassis. Similarly, the reset counter trigger is at pins M and 10; the keying contact is at pins L and 12. Chassis ground (NOT THE RECORDER B-GROUND), is carried through on pins C and 3.

(3) The precision 60 cps output of the Recorder is at pin E. The return of this output is CHASSIS GROUND, pin A. A shielded cable connects the precision 60 cps voltage to the PHONO INPUT of the power amplifier.

(4) The 20 cps pulses appear at pin K. The auxiliary input to the Recorder for these pulses is at pin J (Reference F). The return for both these points is B-GROUND, pin D. A shielded cable connects pins K and J through pins 4 and 2 respectively of P7-J7 to the interrupter switch in the Time Mark Chassis.

The chassis ground lug at the rear of the Electronics Unit is connected to the Ship's sea water Ground.

c. Control Rack

(1) Power Supply - Refer to Figure 22. The 115 V 60 cps AC line enters the Power Supply through the recessed male receptacle and the line cord plugged into the AC outlet on the Power Amplifier. The power switch at the rear of the Power Supply breaks both sides of the line. After this switch the line AC is fed to 2 power supplies; the counter supply, C+, C- and the relay supply, B+, B-.

NOTE: C- IS ONE SIDE OF THE AC LINE. IT IS NOT THE SAME AS CHASSIS GROUND.

NOTE: B- IS THE SAME AS CHASSIS GROUND.

The counter supply is fused with the 5 amp. fuse mounted on top of the chassis. The half-wave rectifier circuit has a 10 ohm, 10 watt current-limiting resistor R1, a 200 MA selenium rectifier, and a 1000 MFD filter condenser made up of C1 and C2. C- is one side of the AC line, C+ is 165 volts positive with respect to C-. C+ and C- appear at pins 2 and 8 of P2 and are color coded yellow and white respectively.

The relay supply is fused with the 1 amp. fuse mounted on top of the chassis. The transformer has one primary and two secondary windings. One secondary winding supplies 2 amps at 6.3 volts for tube filaments. The secondary leads appear at pins 4 and 6 of P2 and are color-coded green. The other winding is a 1:1 isolation winding, one side of which, B-, is grounded to chassis. The other side leads into the half-wave rectifier circuit consisting of current-limiting resistor R2, a 100 MA selenium rectifier, and a 500 MFD filter condenser, C3. B-, or chassis ground, appears at pin 7 and is coded black. B+ is 165 volts positive with respect to B-, appears at pin 3, and is coded red.

P2 plugs into J2 on the Control Chassis.

(2) Counter Chassis - Refer to Figure 23. The Counter Chassis contains 3 identically wired magnetic impulse counters. Leads are brought out to 15-pin male receptacles. Note that the color coding of the pin connections follows the standard resistor color code. For the 2-digit numbers, the tracer follows the same code.

The pulse coil of each counter is shunted by a contact protector consisting of two selenium rectifiers back-to-back. It also is in series with a 200 MA selenium rectifier. The reset coil is in series with a 100 MA rectifier. One side of both coils is common. The operation of the counter is as follows: Initially, or in reset position, the counter contacts are as shown in Figure 23, pin 15, or count 0 being connected to the count common. On the first pulse, the first two contacts on the right fall, disconnecting pin 15 and connecting pin 1, or count 1, to the common through the upper contact in the second line. Similarly the next pulse disconnects pin 1 and connects pin 2 to the common through the upper contact in the third line. Thus each pin is successively connected to the count common as the pulse

coil is energized. Energizing the reset coil returns the connection to the count 0 configuration shown.

Since the three counters are wired identically any one of them may be used as wither the depth or reset counter. The function of the counter is determined by the connections made by the plugs PD and PR which connect the Counter Chassis to the Control Chassis.

(3) Control Chassis - Refer to Figure 24. The Control Chassis contains three trigger circuits - one for pulsing the depth counter, one for pulsing the reset counter and one for resetting both counters. It also contains the transmitting gate, the Control circuit for the receiving gate, and the Master Selector Switch which sets up the gating cycle program.

The depth counter trigger circuit consists of the 82K ohm resistor R1, the single-pole double-throw relay K1, and one-half of tube V1, a 6H6. One side of the relay coil is connected to B+ through deck B of the Master Selector Switch in all but the HDR position. In this position, the trigger, and therefore the depth counter, is inoperative. The other side of the coil is connected to B-, or ground, by the depth counter trigger contact in the Recorder which comes into the Control Chassis through J4, pin 2. The relay contacts connect one side of the depth counter pulse coil to C- through PD pin 14. Note that the other side of the pulse coil is connected to C- through PD pin 12. Thus the depth counter is pulsed once per second. R1 limits the relay coil current; the 6H6 diode eliminates the inductive kick of the coil; the test switch, SW-1, bypasses the relay trigger action for counter testing purposes.

The reset counter trigger circuit consists of the 82K ohm resistor R2, the single-pole double-throw relay K2, and the other half of tube V1. One side of the relay coil is connected to B+ through deck B of the Master Selector Switch in all but the HDR position. In this position, the trigger, and therefore the reset counter, is inoperative. The other side of the coil is connected to B- by the reset counter trigger contact in the Recorder which comes into the Control Chassis through J4, pin 10. The relay contacts connect one side of the reset counter pulse coil to C- through PR pin 14. The other side of the pulse coil is connected to the C+ through PR pin 12. Thus the

reset counter is pulsed once every six seconds. R2 limits the relay coil current; the 6H6 diode eliminates the inductive kick of the coil; the test switch, SW-2, bypasses the relay trigger action for counter testing purposes.

The reset trigger circuit consists of the 82K ohm resistor R11, the SPDT relay K3, 1 MFD condenser, C1, and tube V2, a 6H6. One side of the relay coil is connected to B+ through deck A of the master selector switch, the plug PR, and the reset counter contacts.

This relay operates on reset count 2 (depth count 12) in switch positions 1, 2 and 3; on reset count 3 ( depth count 18) in switch position 4; and reset count 4 (depth count 24) in switch position 5. The relay contacts connect one side of the reset counter and depth counter reset coils to C- through pin 13 of PR and PD respectively. The other side of these reset coils is connected to C+ through pin 12 of PR and PD. Thus the counters are reset in 12, 18 or 24 seconds depending upon the setting of the Master Selector Switch. R11 limits the relay coil current; C1 increases the drop-out time of the relay sufficiently to cover the counter resetting delay; the 6H6 diodes eliminates the inductive kick of the coil; R3 and R4 limit the reset coil current; the test switch, SW-3, bypasses the relay trigger action for counter testing purposes.

Note that the reset relay will also be operated on reset count 5 if this count should be reached. This is a safety feature to prevent "stalling" the counter under certain operating conditions. One such condition, for example, arises if the reset counter is on count 3, and the Master Selector Switch setting is changed from position 5 to position 3.

The transmitting gate circuit consists of the 18K ohm resistors R5 and R6, SPDT magnetic latching relay K4, and 6H6 tube V3. The coil connected between pins 1 and 8 is the gate-opening coil and causes the contact swinger, pin 6, to connect to the contact at pin 7. One side of this coil is grounded and the other connected to B+ through deck C of the Master Selector Switch. In position 1, HDR, this coil is directly connected to B+ and the transmitting gate remains open. In the other four positions, the coil is energized on count 0 through PD pin 15. The coil

connected between pins 2 and 3 is the gate-closing coil and causes the contact swinger, pin 6, to connect to the contact at pin 4. One side of this coil is grounded and the other connected to B+ through deck D of the Master Selector Switch. In position 1, HDR, the connection is open, so that the transmitting gate never closes. In switch positions 2 and 3, the gate is closed on depth count 5, in position 4 it closes on count 8 and in position 5 it closes on count 10. The relay contacts connect the Sounder keying lead, J3-A, to the Recorder keying contact, J4-12, when the gate is open. Thus in HDR position, one ping is transmitted each second. In the 0-2000 and 1600-3200 fathom ranges 5 pings, at one-second intervals, are transmitted every 12 seconds. In the 2800-4400 fathom range 8 pings, at one-second intervals, are transmitted every 18 seconds. In the 3600-6000 fathom range 10 pings, at one-second intervals, are transmitted every 24 seconds. R5 and R6 are current limiters, and V3 eliminates the inductive kick of the relay coils.

The control circuit for the receiving gate consists of the resistive divider networks R7, R9 and R8, R10 the 6H6 diode V4, and decks E and F of the Master Selector Switch. Deck F controls the gate-opening coil of the receiving gate relay; Deck E the gate-closing coil. In switch positions 1 and 2, the gate-opening coil is directly connected to B+ while the gate-closing coil is disconnected. In these two positions the Sonar Signal is always directly connected to the Recorder input. In the other 3 positions the gate always closes at the end of the cycle, the closing coil being energized by count 0 through PD-15. The gate opens in these 3 positions on counts 4, 7 and 9 respectively, in time to record the last of the transmitted pings. The divider networks limit the relay coil current and the control voltage in the cable connecting the Control and Signal Chassis; the diode eliminates the inductive kick; the control voltages are fed to the receiving gate relay through a connecting cable and J1-P1.

The filaments of all the 6H6 diodes are connected to the 6.3 VAC through J2-P2, pins 4 and 6.

(4) Signal Chassis - Refer to Figure 25. The Signal Chassis contains a receiving gate circuit and a signal monitoring circuit. The Sonar Signal enters the chassis

through J5, is limited by the 10K ohm resistor R1, and connects to pin 7 of the receiving gate relay. The recorder input enters the chassis through J6 and connects to pin 6, the swinger of the receiving gate relay. The control voltages for this relay, which is entirely similar to the transmitting gate relay, enter the chassis through P1. When the gate-opening coil, pins 1 and 8, is energized pin 6 connects to pin 7 and the Sonar Signal connects to the Recorder input. When the gate-closing coil (pins 2 and 3) is energized, the Recorder input is shorted to ground. Two receptacles are available for monitoring the signal, a banana-jack type and a phone-jack type. The output of these receptacles is controlled by the signal monitor switch. In SONAR position, the Sonar or ungated signal appears at the output. In RECORD position, the Record input or gated signal appears at the monitoring point. The center position of this switch disconnects the monitor outputs.

(5) Time Mark Chassis -Refer to Figure 26. This chassis consists of a 1/5 rpm hysteresis-type synchronous motor, a cam-switch mechanism, a DPDT relay and an indicator light. The line cord plugs into the Precision AC Loading Chassis making 115 V precision 60 cps power available. The DPDT switch controls the synchronous motor only. The motor drives a switch through a cam causing the relay coil and indicator light to be energized for a few seconds once every five minutes. The beginning of the switching period serves as the time mark. The 20 cps pulses and the auxiliary input of the Recorder enter the chassis through J7 and are connected through the normally closed contacts (pins 3 and 4) of the relay.

The operation of the cam-switch mechanism interrupts this connection every 5 minutes. The motor power switch and indicator light are used in conjunction to align the Recorder time marks with other time marks such as those from WWV or the ship's Chronometer. The unused set of relay contacts are brought out to receptacle J8 and are available for making 5 minute time marks on external equipment.

(6) Precision AC Power Amplifier - Refer to Figure 29 for the circuit diagram of the power amplifier. The precision 60 cps voltage enters the amplifier through the PHONO INPUT jack. The 115 volt output is taken off the OUTPUT

STRIP internally between terminals COMMON (Ground) and 500 OHMS. The following additions and modifications are pertinent to the PDR application of this amplifier.

The AC receptacle is rewired bypassing the power switch. The receptacle is used for the source of AC line power for the Power Supply.

The AC power switch is on the lower right of the front panel of this unit.

The volume or gain control is a screwdriver adjustment at the lower left of the front panel.

The base and treble controls are left in maximum CCW position.

The flexible lead terminated in a lug is connected to the 500 ohm point on the OUTPUT STRIP.

The output is connected to a clock switch and a meter switch. The clock switch connects the clock on the front panel to the Precision AC in one extreme position and to the line AC in the other. The center position is off. The meter switch connects the 0-150 volt AC meter to precision AC in one position and line AC in the other. The output is also connected, through a line cord, to the Precision AC loading chassis.

(7) Precision AC Loading Chassis - Refer to Figure 27. This chassis contains 3 condensers with their associated switches for power factor correction of the precision AC load a 10 watt lamp for a dummy load, and 2 receptacles for external connection to the 115 volt precision AC line.

The 3 condensers, 0.5, 1.0 and 2.0 MFDS, may be connected across the line in 7 different arrangements giving capacitor values of .5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 MFDS. The 10 watt lamp load is a dummy load required for proper operation of the power amplifier. The load, plus the Clock and Time Mark motors, draws about 15 watts from the amplifier. If more than 15 watts additional is required, the lamp is removed.

## SECTION III - INSTALLATION

### 1. PHYSICAL INSTALLATION

a. Data - The Recorder and Control Rack weigh between 300 and 400 pounds. The Recorder requires a minimum area of 30" x 30" for seating and a vertical space at least 48" high. The Control Rack requires an area of 24" x 30" and a vertical space at least 48" high.

b. Mounting - The two units are mounted side by side on a bench (usual height above deck 30"), running fore-and-aft. The fore-and-aft requirement is necessary for proper operation of the chart feed drive in the Recorder and the counters in the Control Rack. Each unit is seated on 4 shock mounts which are secured to the bench. The Recorder needs overhead clearance of at least 30" for lifting the cover, and provision for securing the cover in the open position.

The exhaust tube of the blower also needs to be secured to a suitable vent space. Adequate ventilation is a serious consideration for this equipment, as the carbon particles and fumes emitted from the Recorder may cause the operator considerable discomfort.

c. Sonar Sounding Set - Provision for leading the keying leads out of the Sounder case is required. If it is desirable to switch over from PDR recording to using the Sounder recorder, one switch for the drive motor and one for the keying leads must be secured in a convenient location.

### 2. ELECTRICAL INSTALLATION

a. Data - The PDR equipment requires a Sonar Sounding Set with transducer, receiver, and transmitter in good working order. AC power at 115 volts, 60 cycles per second, single phase, in the amount of 350 watts must be supplied.

b. Cabling - The AC power connections are made through the line cords of the Recorder and the Power Amplifier. The Power Supply of the Control Unit is plugged into the AC receptacle at the rear of the Power Amplifier.

An 8-foot connecting cable is supplied for interconnecting Recorder and Control Rack. One end, the 14-pin plug, plugs into the Recorder - the other end is split into

4 parts. The RCA Phono Plug goes into the PHONO INPUT receptacle on the Power Amplifier; the 12-pin Cannon plug goes into the rear of the Control Chassis (J4); the 3-pin Cannon plug goes into the Record Signal receptacle on the Signal Chassis (J6); the 4-pin Cannon plug goes into receptacle J7 on the Time Mark Chassis.

Two 15-foot cables are supplied for interconnecting the Sounding Set and Control Rack. One cable plugs into J5 on the Signal Chassis and into the EARPHONE jack on the front panel of the Sounder. The other cable plugs into J3 on the Control Chassis at one end and is connected to the keying leads at the other end.

In addition to the cabling connections, a 0.1 MFD 600 V, condenser is to be connected in shunt with C-221 in the Sounder; the drive motor of the Sounder is to be either disconnected or connected as shown in Fig. 3-3, Reference C; the Sounder styli are to be removed from contact with the chart or any other part of the Sounder by moving the rubber b lt which holds them. Details of connections for switching the operation from PDR to normal are left to the operator.

# SECTION IV - OPERATION

## 1. INTRODUCTION

This section will enable the operator to use the equipment to accomplish its intended function. It is presumed that the equipment is originally shut off but connected to the 115 volt 60 cps single-phase ship's supply, and that all the interconnections between Recorder, Control Rack and Sounding Set have been properly made. The ground lug on the Recorder must be connected to sea water ground.

NOTE: IN CASE OF A POWER FAILURE OF THE AC LINE TURN OFF ALL THE EQUIPMENT IMMEDIATELY AND START ALL OVER.

The equipment is turned on and off at 4 places:

The Recorder power is controlled by the switch on its front panel. See Figure 12.

The Control Unit power is controlled by the switch at the rear of the Power Supply. See Figure 2.

The Power Amplifier power is controlled by the switch on its front panel. See Figure 11.

The Sounding Set power is controlled by the switch on its front panel. See Figure 4-1 in Reference C. The PING SWITCH should be turned on after the power switch and turned off before the power switch.

## 2. CAPABILITIES AND LIMITATIONS

a. Capabilities - The PDR MK IV-A equipment is capable of operating in any depth of water and providing a dense, highly precise record of the bottom. The operator has a choice of 2 types of operation:

(1) High Density Recording (HDR) and
(2) Gated Operation.

He also has a choice of 3 traverse speeds with which to control the vertical exaggeration of the record: 6, 24 and 96 inches per hour.

b. Limitations - The operator must bear in mind certain limitations of the equipment.

(1) High Density Recording may be used only if the noise interference is small enough to allow it.

(2) For Gated Operation, the Master Selector Switch must be set to the appropriate depth range. Change range between the 0-2000 and 1600-3200 steps at 2000 fathoms between 1600-3200 and 2800-4400 and 3600-6000 steps at 4000 fathoms.

(3) The operator must resolve the ambiguity of the base line. This line, made by the recording of the transmitted pings, represents some multiple of 400 fathoms of depth, The operator must maintain a record of the base line value on the chart itself or in a separate log. Several methods are suggested:

A. By correlating the ship's position and available hydrographic information.
B. By starting from a known base line (as in port), and marking the record each time it runs off scale.
C. By listening with earphones at the monitor jack and counting seconds between the transmission and reception of the last ping of a group. (Gated Operation). In HDR operation, the PING SWITCH on the Sounding Set may be used to turn off the pings until the last ping has been timed.
D. By switching to normal operation on the 6000 fathom scale of the Sonar Sounding Set. This requires that the switching arrangements be available.

(4) The gain of the recording system must be set for optimum response. The gain is controlled at 2 places; on the front panel of the Sounding Set and on the front panel of the Recorder. The latter is a step-type control and should be set and left. The Sonar Sounding Set gain control should be set at as low a setting as will result in a clear record. Emphasis should be placed on this point: - The gain setting of the recorder system should be as low as is consistent with obtaining a clear record.

The step-type gain control on the Recorder should be set so that the continuous-type Sounder control operates in a convenient range.

3. OPERATIONAL PROCEDURE

a. Sonar Sounding Set

(1) Starting the Equipment: -

NOTE: THIS EQUIPMENT SHOULD ALWAYS BE TURNED ON LAST AND SHUT OFF FIRST.

The equipment is turned on by the power switch on the front panel. If immediate operation is not required, it may be left in STANDBY position.
The PING SWITCH should be the last thing turned on and the first turned off in the entire operating procedure.

(2) The recorder unit should be disconnected and the styli moved off the paper.

(3) The gain level should be adjusted as described under Capabilities and Limitations above.

b. Recorder

(1) Starting the equipment. - The equipment is started by means of the selector switch on the front panel (fig. 12).

A. SWITCH TO STANDBY AND WAIT 30 SECONDS.
B. SWITCH TO START AND WAIT 10 SECONDS.
C. SWITCH TO SYNC AND WAIT FOR MOTOR TO FALL INTO SYNC SPEED. THIS IS DISTINGUISHED BY THE DISTINCTIVE HIGH PITCHED TONE.

If the motor does not lock in but falls through synchronous speed, switch back to START position and repeat steps B and C. If the motor does not come down to synchronous speed, turn to STANDBY and allow the motor to stop. Omit step B and switch directly to SYNC position.
D. SWITCH TO RUN POSITION.

(2) Loading paper. - The paper is loaded with the recording system stopped. Turn the selector switch back to SYNC position to stop, and to RUN position when ready to start recording again.
CAUTION: DO NOT TURN SELECTOR SWITCH BACK PAST SYNC UNLESS IT IS DESIRED TO SHUT DOWN.

THE PRECISION 60 CPS GENERATOR IS DRIVEN BY THE SYNC MOTOR AND WILL CONTINUE TO OPERATE IN SYNC POSITION EVEN THOUGH THE RECORDER IS NOT RUNNING. IF THE SELECTOR SWITCH IS BACKED PAST SYNC POSITION, THE PRECISION AC IS LOST AND ALL TIME MARKS MUST BE RESET.

A. Lift Hood cover and remove old core.

B. If leading edge of new paper roll is ragged, trim with scissors. Hold paper with top unrolling toward front of recorder.

C. Load new roll by centering on left-hand cone and pushing to left until right hand cone engages into right hand core hole.

D. Remove the one stylus needle that will be found on the track. (SEE INSTRUCTIONS FOR CHANGING STYLUS NEEDLES).

E. Lift paper feed rollers in front by use of cam rod lever to permit rear feed rollers to engage. Lead paper onto platen at back of drum.

F. Revolve manual advance knob and draw paper around to front until paper passes up behind the trolley bar. Keep slack in rear by advancing paper roll by hand.

G. Slip paper under lucite bar and lower front rollers. Advance paper with manual advance knob until all slack is gone and paper is straight and square. Tear off excess at the lucite cutter.

CAUTION: MAKE CERTAIN THAT PAPER FEED ROLLER IS PROPERLY ENGAGED BY ASSURING THAT CAM ROD LEVER IS AGAINST STOP AND ALSO CHECK TO SEE THAT THERE IS PROPER TENSION ON THE BACK SIDE BETWEEN DRUM AND PAPER ROLL.

H. Reinsert stylus. (SEE INSTRUCTIONS FOR CHANGING STYLUS NEEDLES). Lower hood cover, then manually advance paper a few inches beyond the chrome platen. The roll contains 350 feet of paper. At 6 inches per hour it will last 700 hrs. or over 29 days. At 24 inches per hour it will last 175 hrs. or over 7 days. At 96 inches per hour it will last 43 3/4 hours.

(3) Adjust gain control - the gain control should be adjusted so that the sounder gain control operates over a convenient range. It should then be left in this position.

(4) Event Marker - the push button switch on the front panel labelled "PHASE" is wired to put a test signal into the recorder. The black lines appearing on the record when

this switch is pushed may be used to mark events of interest to the operator.

(5) Circuit Test Switch - See Reference A.

(6) Traverse Gears - Two sets of traverse gears are provided allowing for 3 speeds of chart paper feed. One set of gears is in use. The other set is mounted, with an Allen wrench, at the right rear of the electronics chassis.

The gears are held on their shafts by retainer clamps which slip off when the Allen screws are loosened. The arrangements of the gears for the various speeds are shown in Figures 4, 5 and 6. The chart roll should be removed before changing gears and replaced afterward. (SEE INSTRUCTIONS FOR LOADING PAPER).

CAUTION: HANDLE THESE GEARS WITH EXTREME CARE. DO NOT DENT THE TEETH OR OTHERWISE DAMAGE THEM OR THE RECORDER MECHANISM MAY JAM. WHEN FITTING A NEW SET OF GEARS BE ESPECIALLY CAREFUL TO SEAT THEM PROPERLY AND MATE THEM WITHOUT FORCING.

c. Control Rack

(1) Starting the Equipment - the Control Unit is turned on by the power switch at the rear of the Power Supply. The Power Amplifier is turned on by the power switch at the lower right side of its front panel.

(2) Master Selector Switch - If operating conditions permit, this switch should be left in HDR position. This is the most desirable method of operation from the viewpoint of sampling density. If Gated Operation is necessary due to excessive noise interference, the switch must be set for the appropriate depth over which the vessel is operating.

Changes in range should be made when the depth is at an integral number of thousands of fathoms; Change between steps 2 and 3 at 2000 fathoms; between steps 3 and 4 at 3000 fathoms; between steps 4 and 5 at 4000 fathoms.

(3) Signal Monitor - The signal may be monitored by a high impedance (10,000 ohms or more) device at the jacks on the front panel. A Cathode Ray Oscilloscope and the Headset supplied with the AN/UQN-1B Sounder are suitable devices.

The signal monitor switch connects the monitor jacks to either the Sounder output, the Recorder input, or disconnects them. The gating operation may be checked when the switch is in the RECORD SIGNAL position.

(4) Adjust Precision AC Level - the voltage level of the Precision AC output should be set to 115 volts under load. This is done with the aid of two controls, the potentiometer gain control at the lower left side of the Power Amplifier front panel, the condenser switching array on the Loading Chassis, and the 0/150 volt AC meter.

First, set the meter switch to read precision AC. Using the gain control, set the level to 100 volts. Operate the condenser switches to tune the load voltage to a maximum. Finally, use the gain control again to set the level at 115 volts. The meter switch should be left in the precision AC position except when checking line voltage so that failure or malfunction of the precision AC supply is indicated.

If additional loads are placed on the precision AC supply, the level should be adjusted again in the same manner. Note that the maximum load for the precision AC line is 25 watts. The 10 watt lamp dummy load may be removed if more than 15 watts of external power is required.

(5) Set Clock - the clock should be set to WWV time or Ship's Chronometer Time, whichever suits the operator. The clock switch is placed to OFF (center) position when the second hand is on zero seconds. The minute and hour hands are then set from the rear of the panel to correspond to the next time break of either WWV or Chronometer. On the time break, the clock is started. With practice, the operator should be able to perform this operation taking into account any small delay in starting the clock motor. The clock switch may be put in LINE AC position if the precision AC should fail.

(6) Time Marks - Time Marks are made on the record by interrupting the 20 fathom Mark lines at 5 minute intervals for a few seconds. These marks should be adjusted to correlate with exact 5-minute marks of WWV or the Ship's Chronometer, whichever is used. The switch on the Time Mark chassis controls the timing motor power. The neon

light indicates the interruption of the 20 Fathom marks. Switch the motor OFF as soon as the light goes on. Switch the motor ON exactly on the 5 minute mark of the standard. The operator should mark the time breaks on the record so that they may be identified.

## SECTION V - OPERATOR'S MAINTENANCE

### 1. INTRODUCTION

The operator should be sufficiently familiar with the details of the Precision Depth Recorder system to service minor defects without technical assistance.

a. Routine Check List - As an aid in obtaining reliable and uninterrupted performance, the following items should be routinely checked at each change of watch:

A. Log information. This includes especially the Base Line and Time Mark information.
B. Recording paper supply. Check supply on chart and in stock.
C. Stylus needle. If needle length is less than 1/32 inches, or record is spotty, replace.
D. Gain setting. See that lowest gain setting consistent with good clear record is being used. Use Sounder gain control for adjustment.
E. Gating cycle. Check with oscilloscope or earphones.
F. Precision AC Level. If not 115 volts, adjust.
G. Time Marks. These should check with clock.

### 2. SONAR SOUNDING SET - See Reference C.

### 3. RECORDER

a. Trolley Bar - DO NOT CLEAN THE TROLLEY BAR. DO NOT APPLY OIL TO THE TROLLEY BAR. The Trolley Bar and the bushings of the stylus holders which slide across it have been selected of materials which require no lubrication.

b. Instructions for Changing Stylus Needles - The need to change stylus needles will be noted by gaps or streaks in the printing. The needles may be changed in the following manner:

With the control at SYNC position, revolve wheels till the stylus holder is near the middle of the track. Carefully lift the fine spring wire out of the slot and remove stylus needle.

CAUTION: DO NOT DEFORM SPRING WIRE IN ANY WAY.

Install a new needle in place making certain that the flatted end of the needle is uppermost. Carefully slip spring wire back into slot.

c. Installing a New Band Assembly - Installing a new band assembly is not considered an operator function, but when instructed or in an emergency may be performed as follows:

A. Set Control in SYNC position.

B. Remove styli from band (SEE INSTRUCTIONS FOR CHANGING STYLUS NEEDLES).

C. Slip band around left hand wheel.

NOTE: LOCATE THE BAND SUCH THAT END OF HOLD-BACK ARM WITH WHITE DOT IS IN FRONT OF EMPTY LUG.

D. Carefully lay top section of band onto right hand wheel. Turn right hand wheel meanwhile, gently pushing flat section of band onto remainder of wheel.

CAUTION: NOTE THAT BAND IS FULLY ENGAGED ONTO WIRE GUIDES ON THE WHEEL RIM.

E. Reinsert styli as per instructions.

F. Check transmitted ping line to see if phase position is correct. (If end of hold-back arm with white dot is in front of stylus assembly instead of empty lug, base line will appear in middle of sheet).

d. Keying and Trigger Contacts - Most of the troubles encountered with these contacts may be overcome by cleaning the contact wheels with a clean rag. This should be done by holding the rag against a clear portion of the wheel with light pressure while it is turning.

Ocassionally the contact brushes may have to be replaced. If this is done, an hour or two running time should be allowed for wearing in the brushes.

If the paper roll is removed to work on the contacts, be sure to follow paper loading instructions given above.

4. CONTROL RACK

a. Gating Cycle Program - If a check of the gating cycle shows malfunction, first check to see if the counters are operating. This may be done by sliding out the Control Unit shelf and looking through the lucite window.

If the counters are operating properly the cause of

trouble is probably in the gating relays.

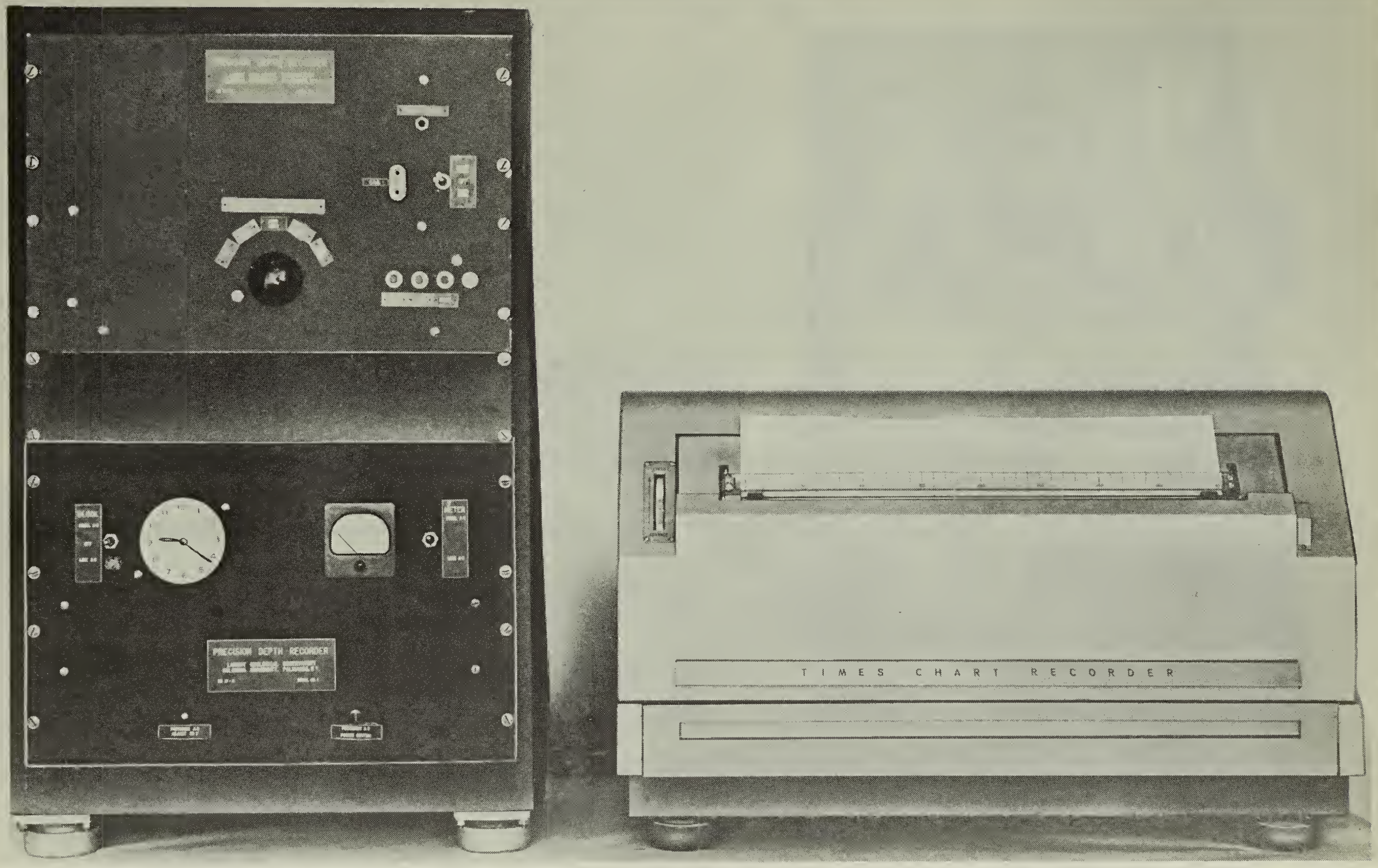
If the counters are not operating, check the trigger relays by placing the finger lightly on the relay case. If the trigger relays are operating properly, the cause of trouble is probably in the Counter Chassis. If the trigger relays are not operating properly, disconnect plug P4, and operate the counters with the test switches on the front panel. If the counters now operate properly, the cause of trouble is either in the trigger relays or the Recorder trigger contacts. The contacts may be checked with an ohm-meter at P4.

Note that the similarity of several components may make trouble isolation easier by the use of interchangeability. The Counters may be interchanged with each other and with the spare. The 3 trigger relays may be interchanged. The two gating relays may be interchanged.

b. Precision AC - If the precision AC supply fails, the Power Amplifier should be checked by ordinary point-to-point methods. Reference H shows the proper voltages at various points in the circuit.

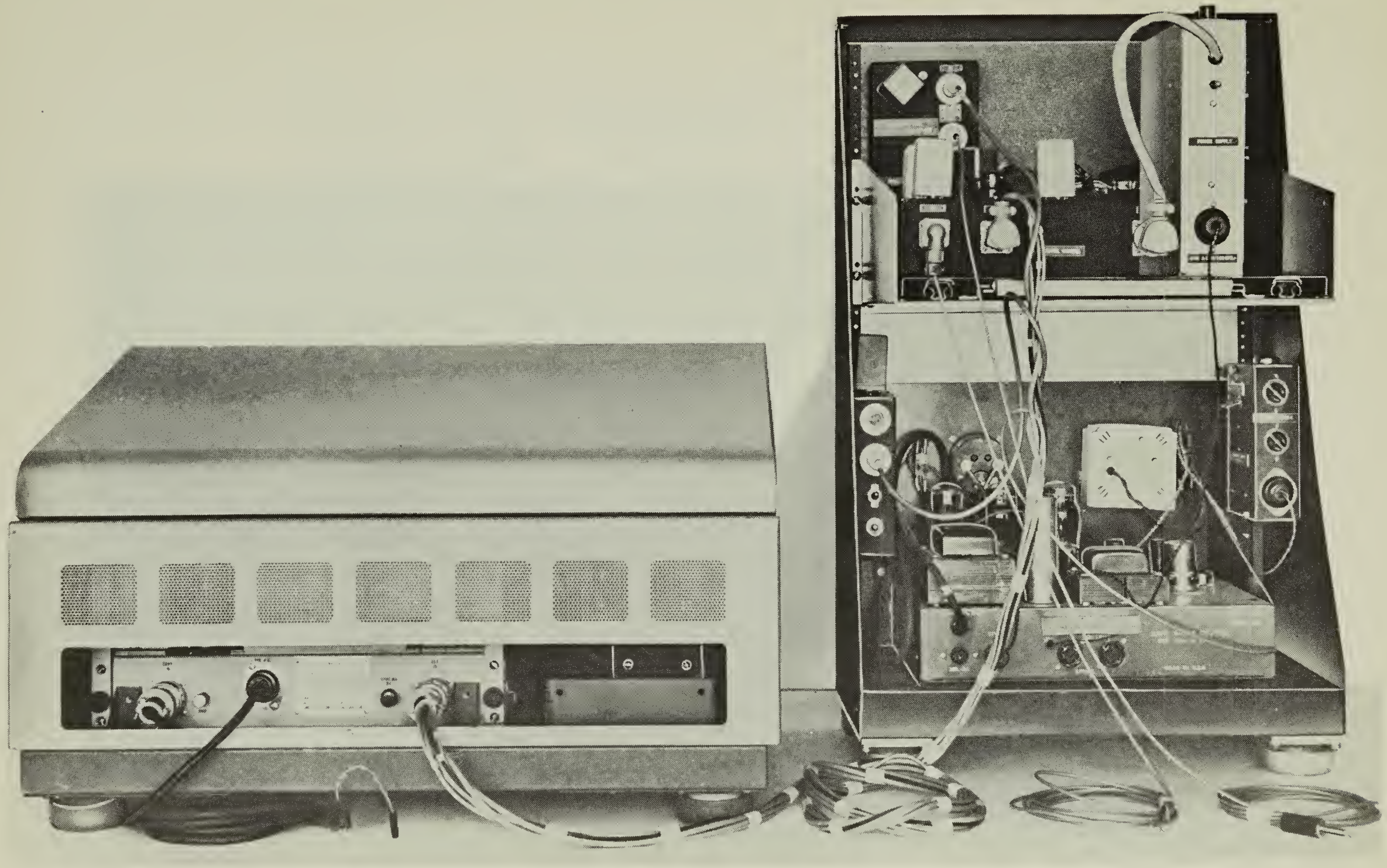
If the precision AC line voltage fluctuates, the cause of the trouble may be a burned out 10 watt bulb in the Loading Chassis.

NOTE: IF THE OPERATION OF THE PDR (OTHER THAN THE PRECISION AC SYSTEM) IS STOPPED FOR ANY REASON - TURN OFF THE PING SWITCH FIRST.




PRECISION DEPTH RECORDER. FRONT VIEW

Fig. 1



PRECISION DEPTH RECORDER REAR VIEW

Fig. 2

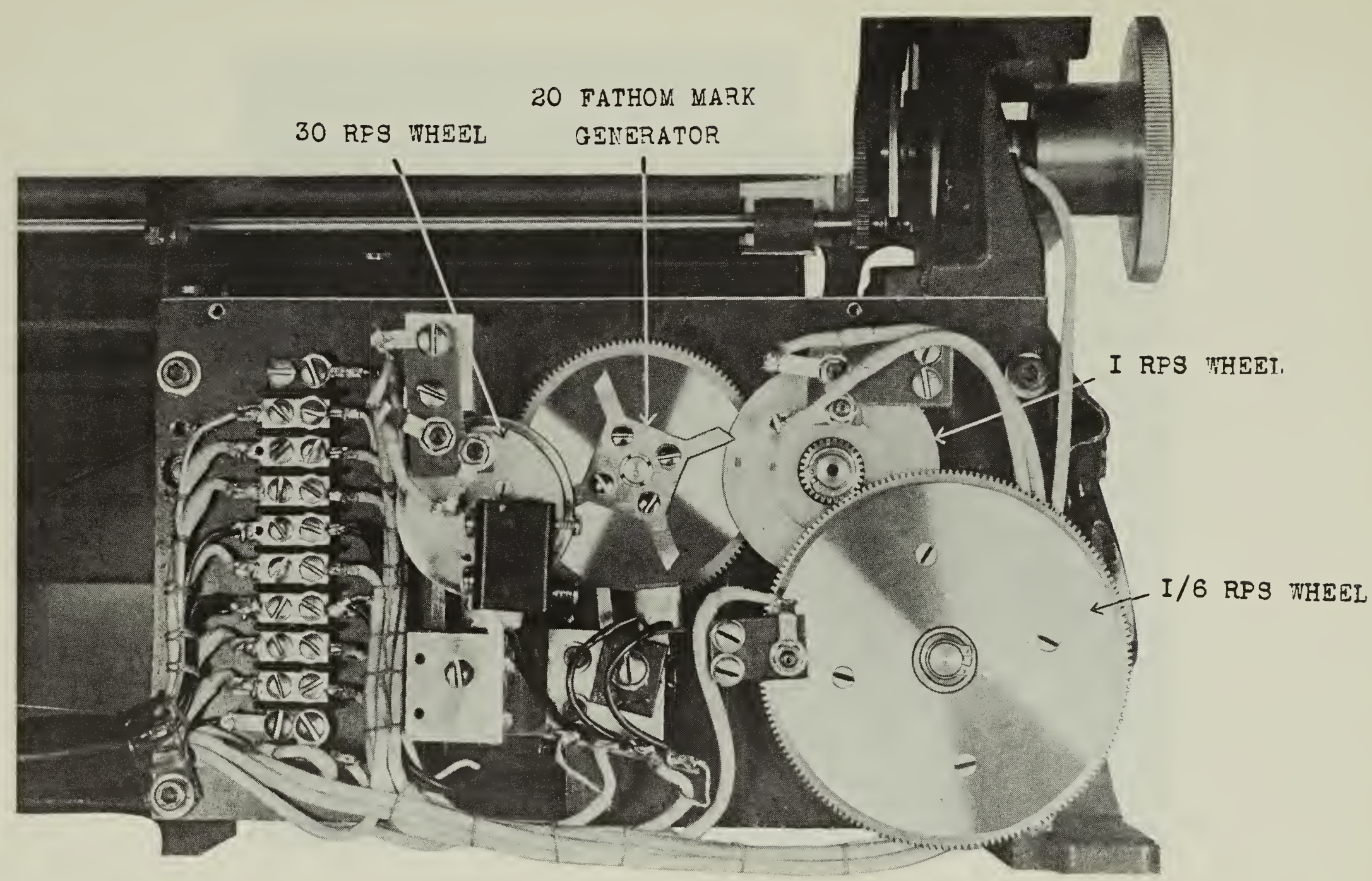

30 RPS WHEEL
20 FATHOM MARK GENERATOR
I RPS WHEEL
I/6 RPS WHEEL
CHART RECORDER
CONTACT ASSEMBLY

Fig. 3

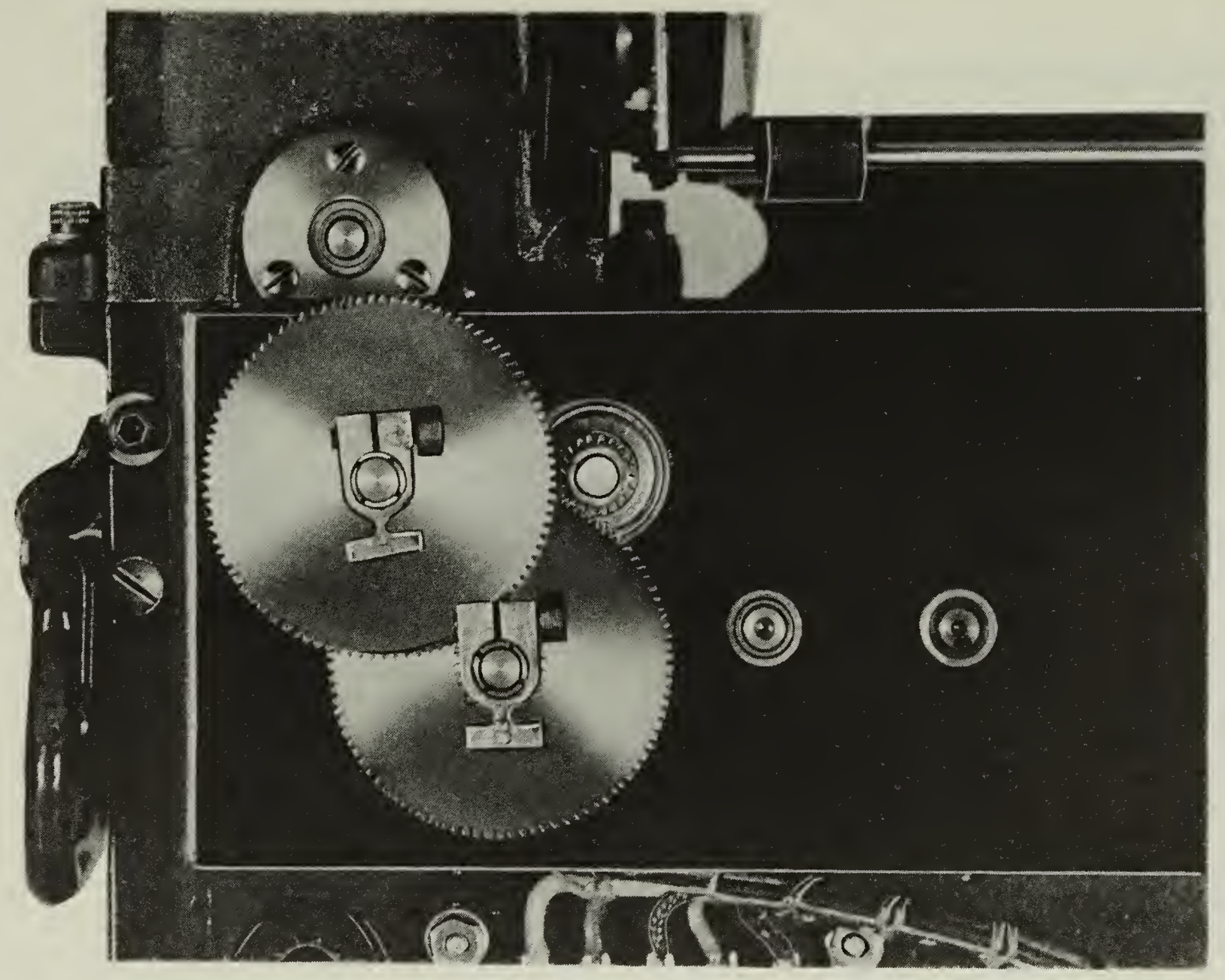


CHART FEED CHANGE GEARS
6 INCHES PER HOUR

Fig. 4

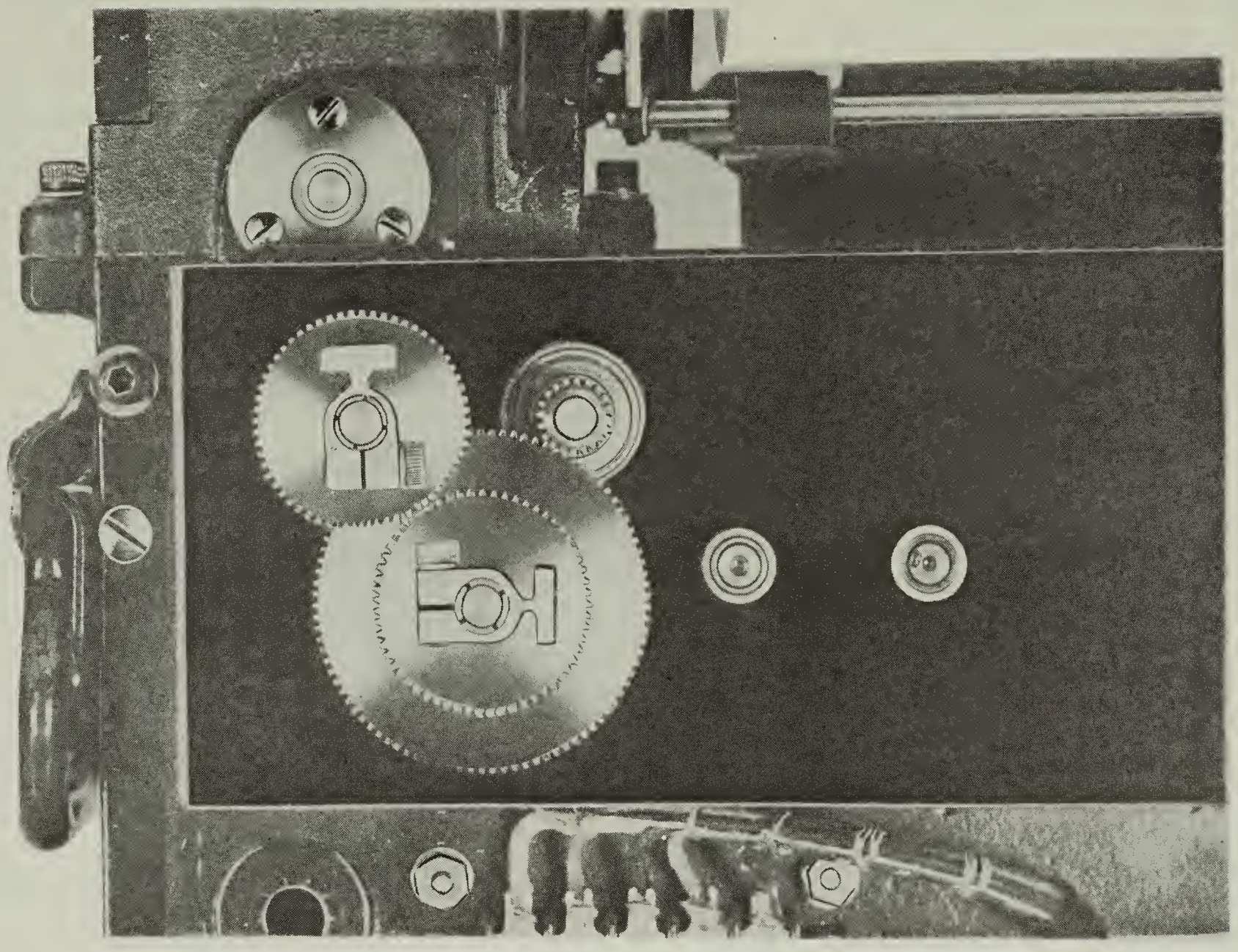


CHART FEED CHANGE GEARS
24 INCHES PER HOUR

Fig. 5

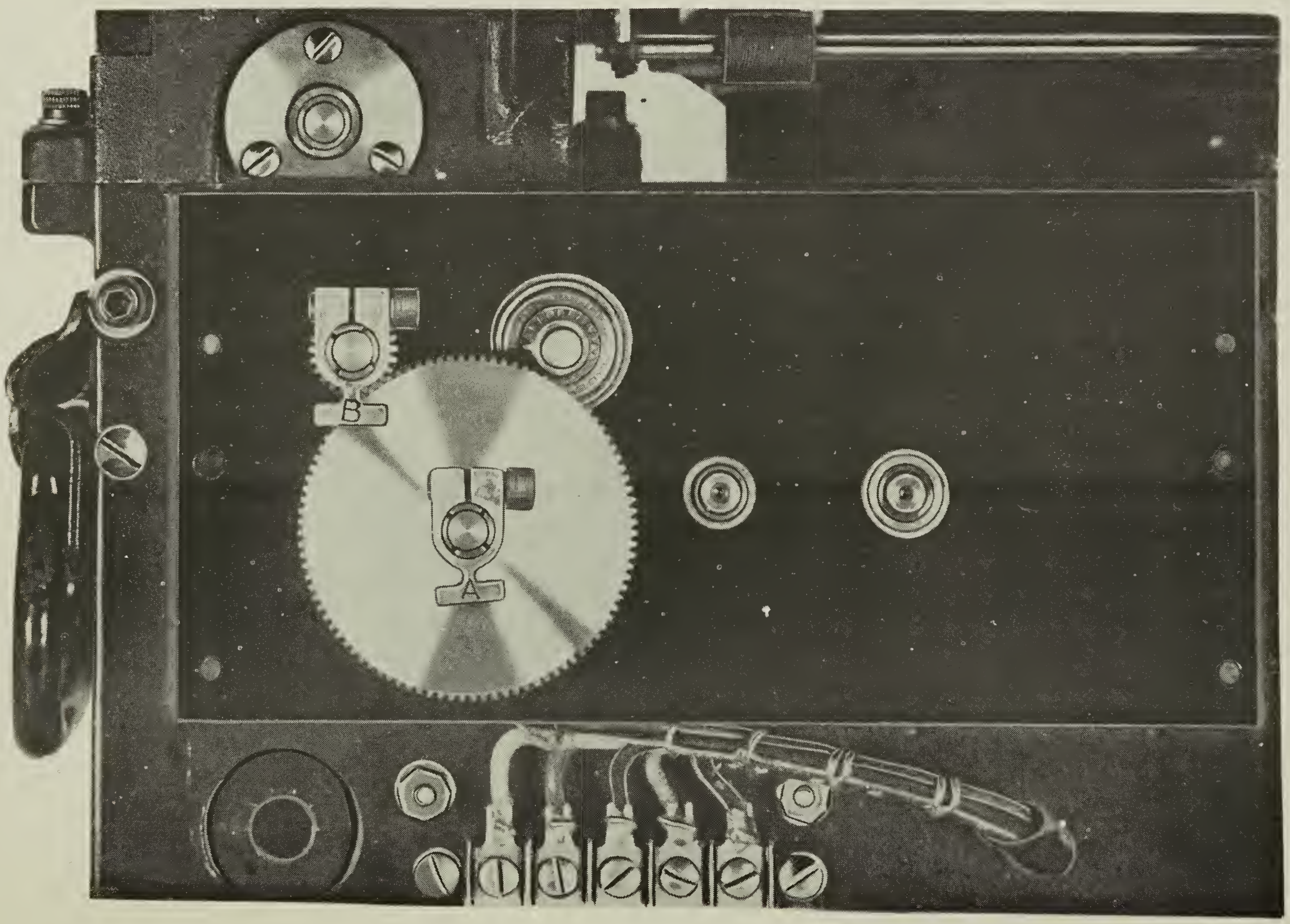
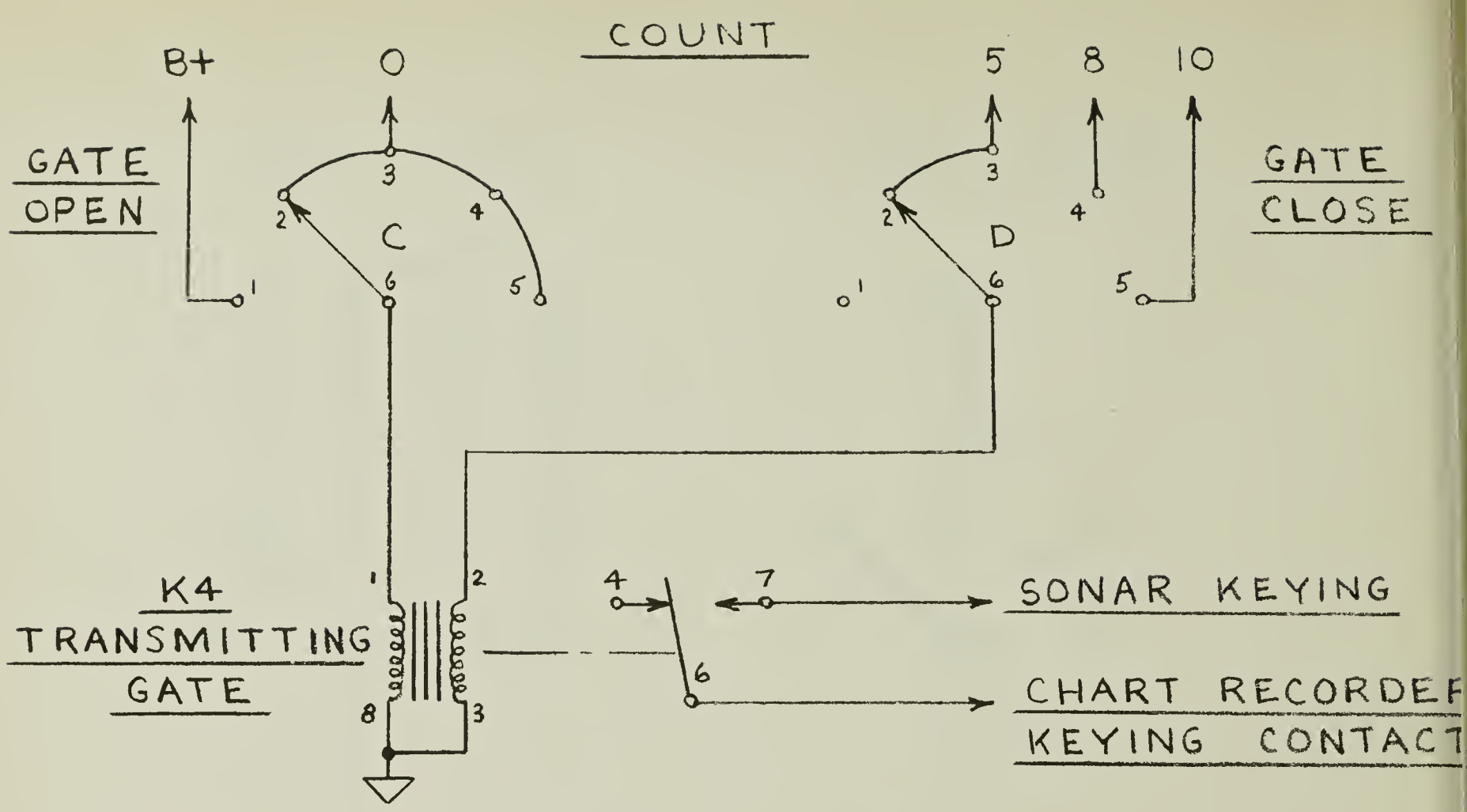



CHART FEED CHANGE GEARS 96
INCHES PER HOUR

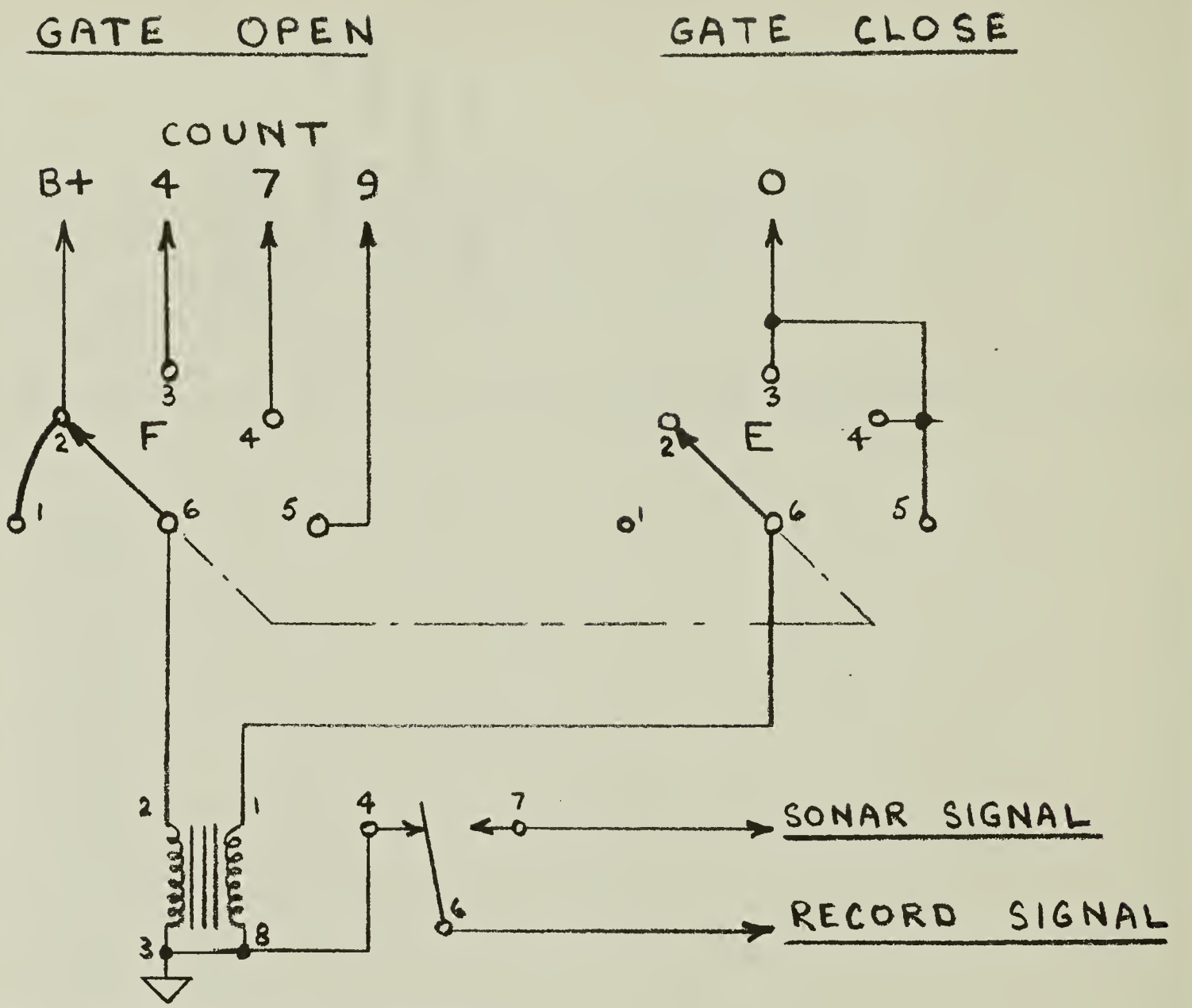



| SWITCH POSITION | DEPTH IN FATHOMS |
|---|---|
| 1 | HDR |
| 2 | 0 – 2000 |
| 3 | 1600 – 3200 |
| 4 | 2800 – 4400 |
| 5 | 3600 – 6000 |

FIGURE 7

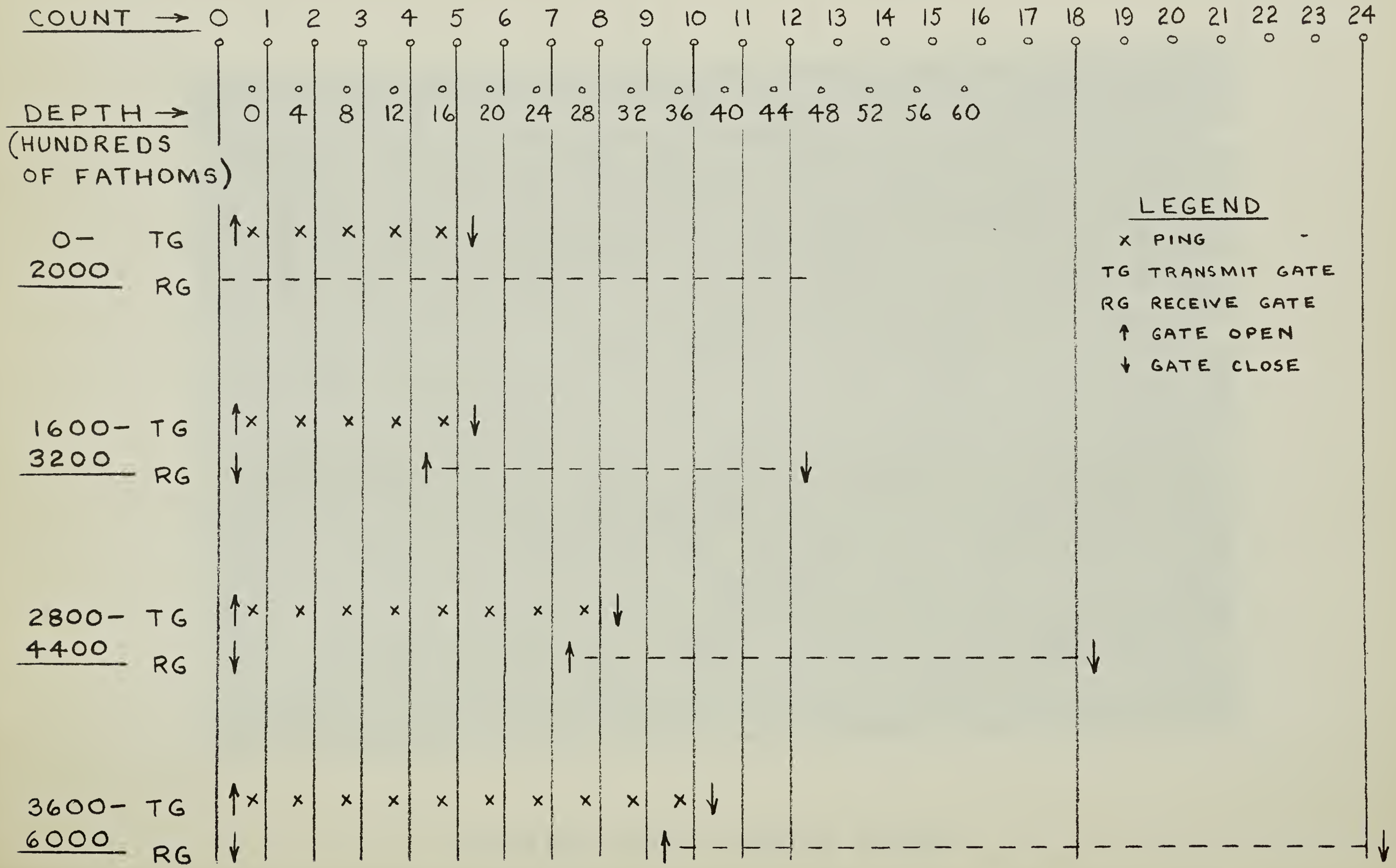
TRANSMITTING GATE (SIMPLIFIE

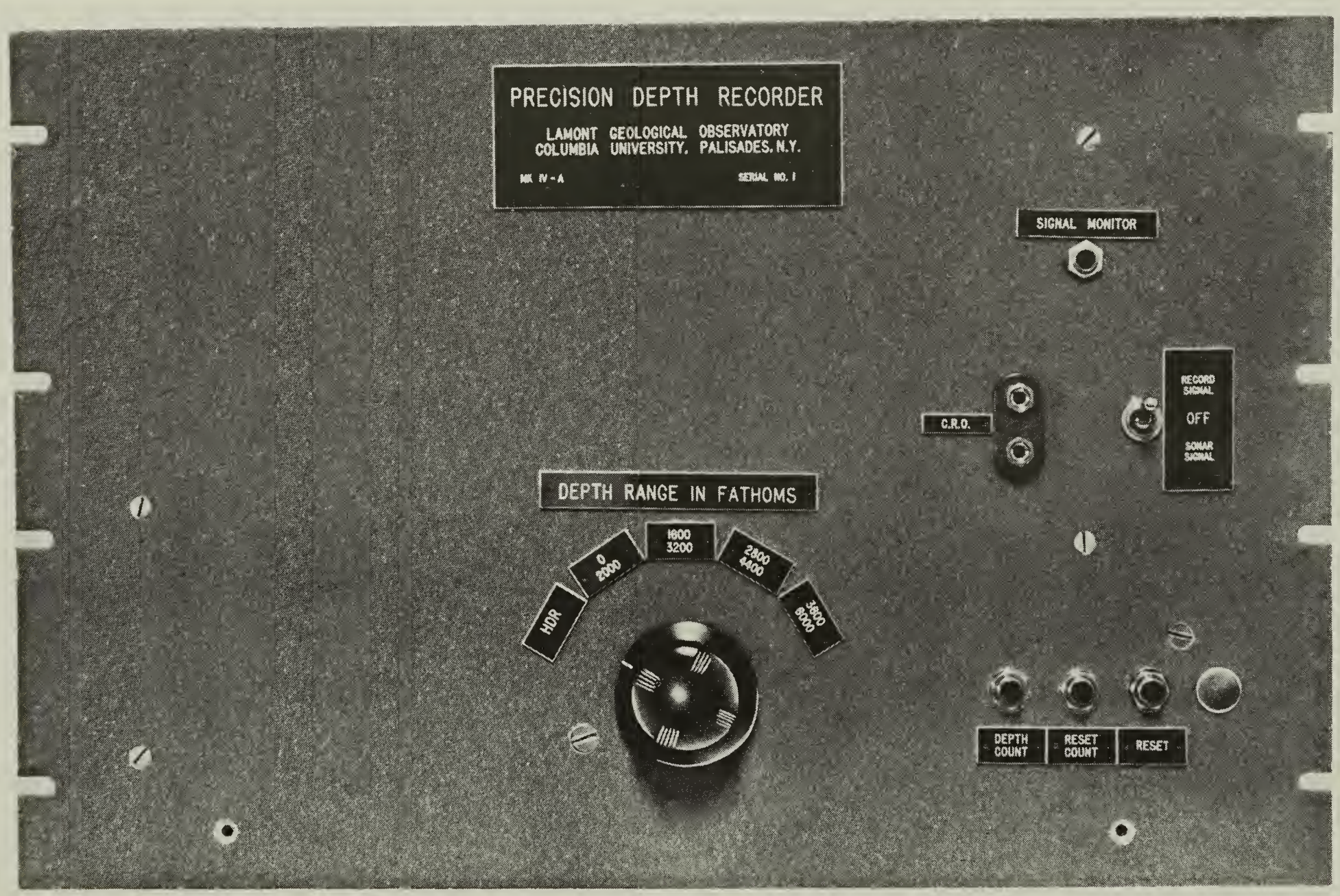
PDR MK IV-A



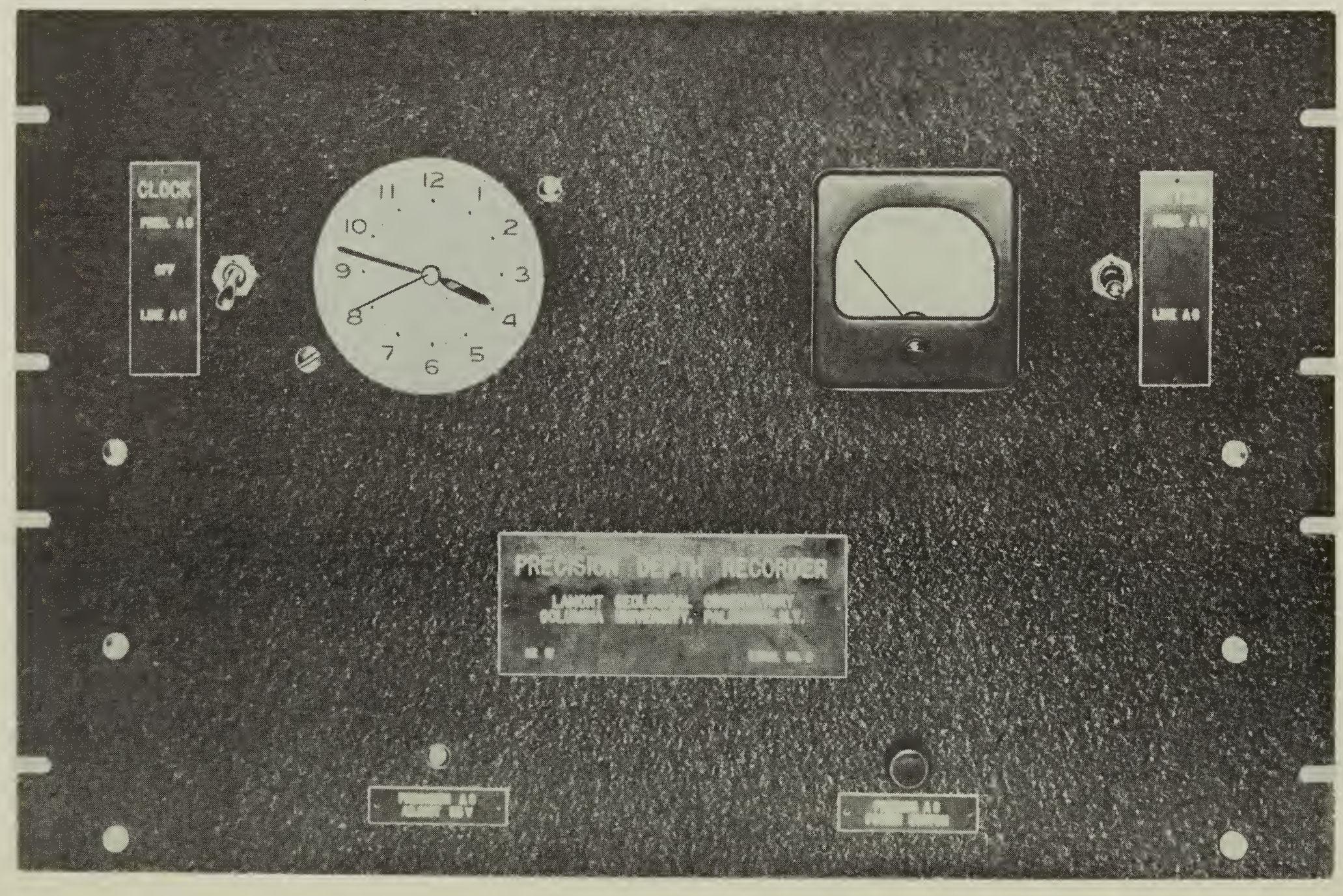

| SWITCH POSITION | DEPTH IN FATHOMS |
|---|---|
| 1 | HDR |
| 2 | 0 - 2000 |
| 3 | 1600 - 3200 |
| 4 | 2800 - 4400 |
| 5 | 3600 - 6000 |

FIGURE 8
RECEIVING GATE CKT. (SIMPLIFIED)
PDR MK IV

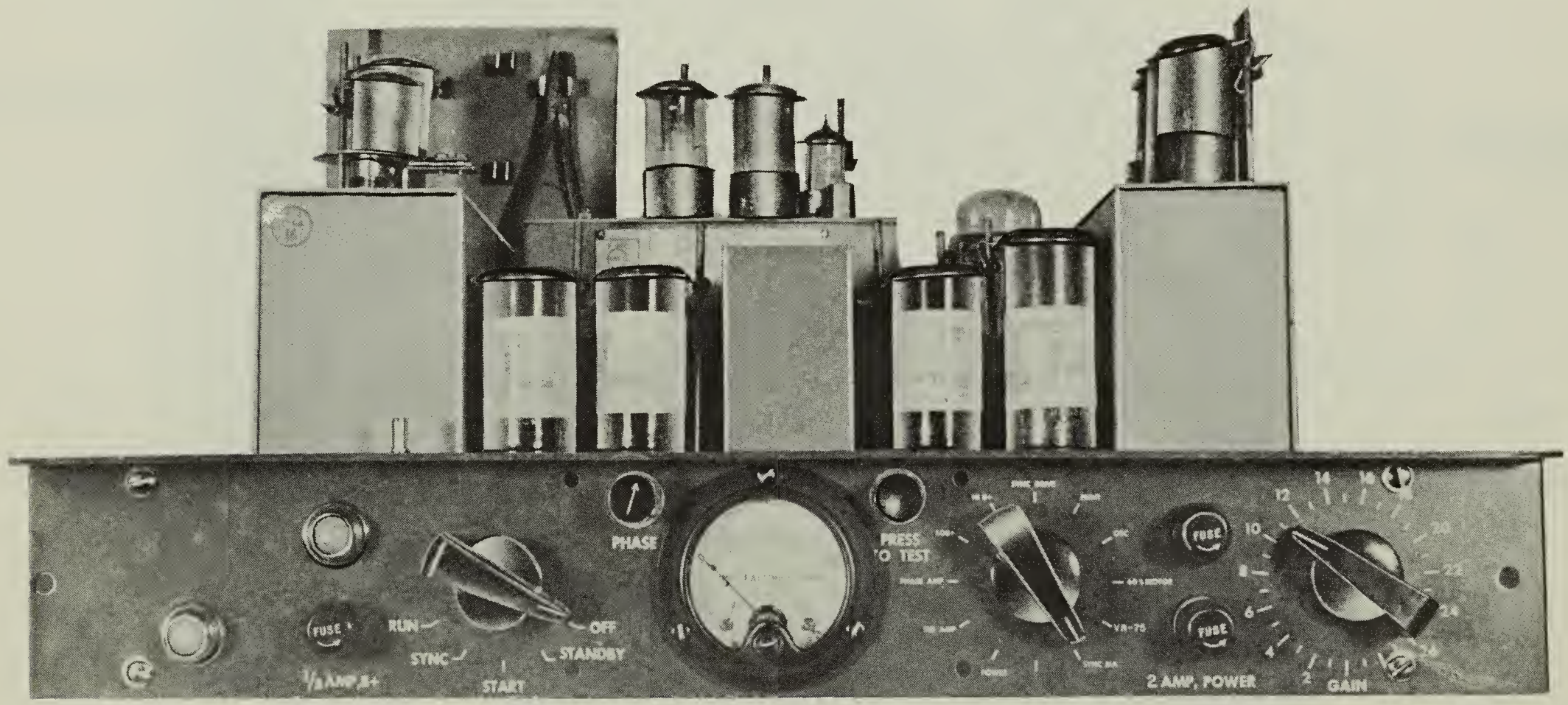

COUNT → 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
DEPTH → (HUNDREDS OF FATHOMS)
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60
0- 2000 TG
RG
1600- 3200 TG
RG
2800- 4400 TG
RG
3600- 6000 TG
RG
LEGEND
X PING
TG TRANSMIT GATE
RG RECEIVE GATE
↑ GATE OPEN
↓ GATE CLOSE



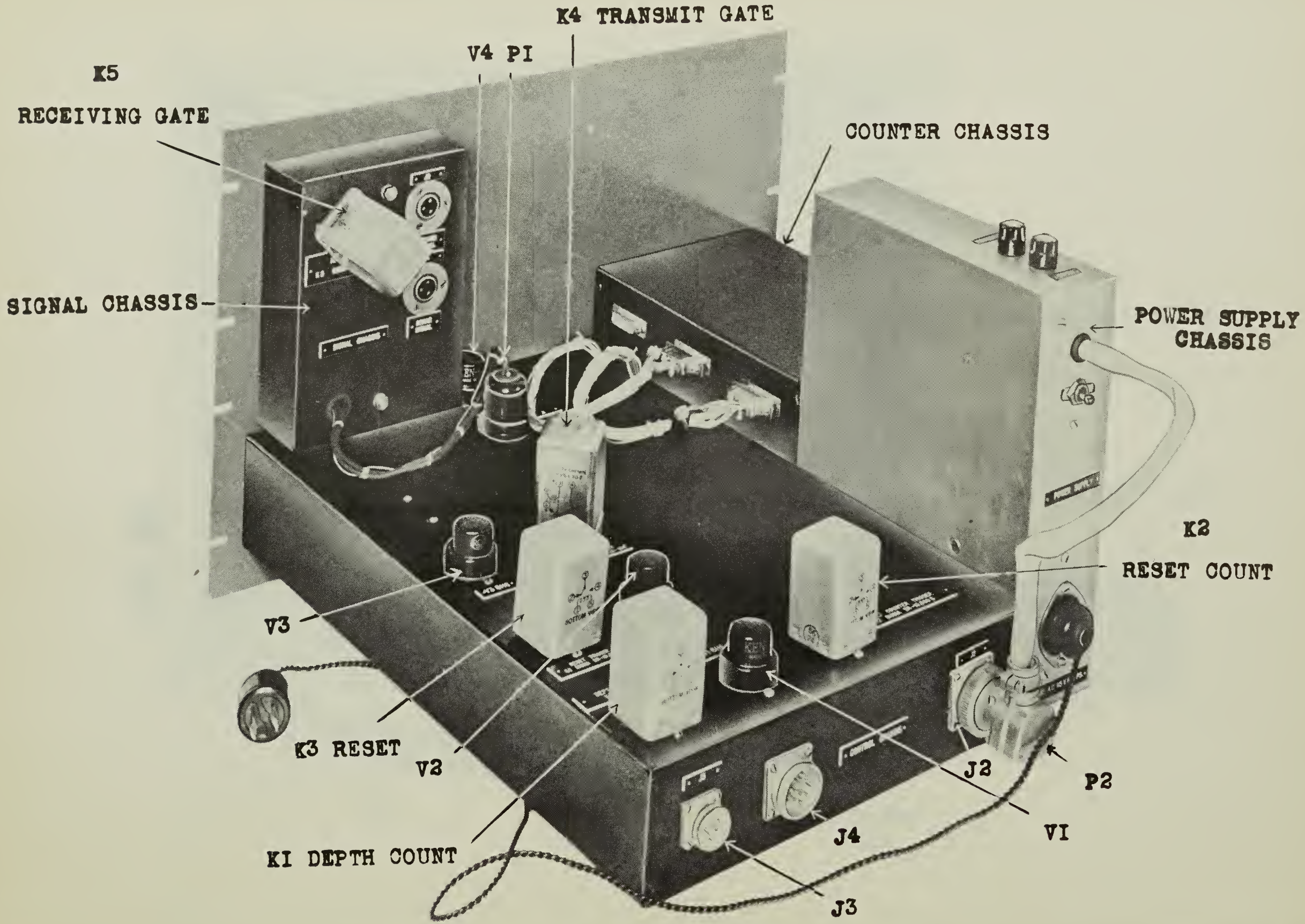

CONTROL UNIT FRONT PANEL



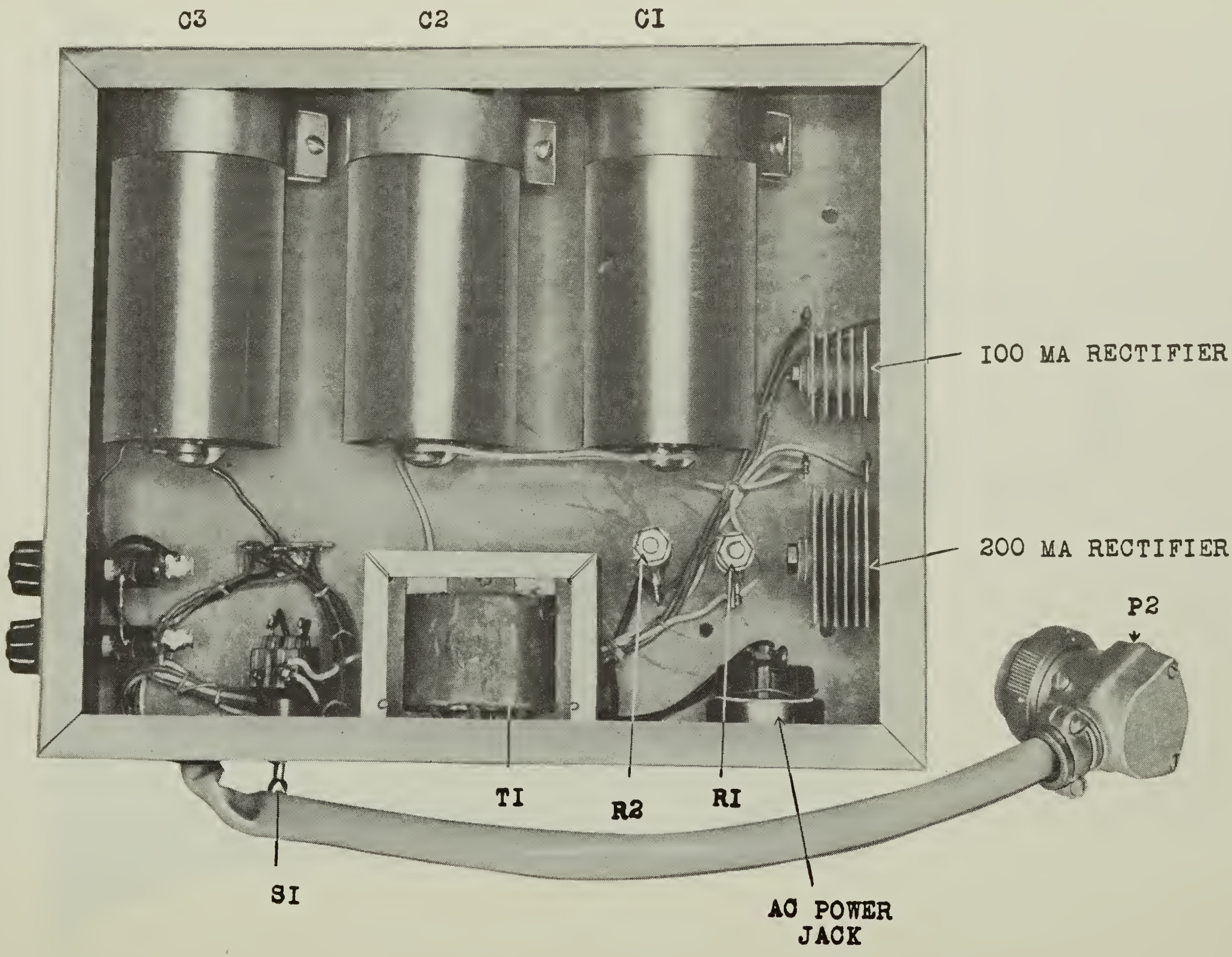

PRECISION AC UNIT FRONT PANEL



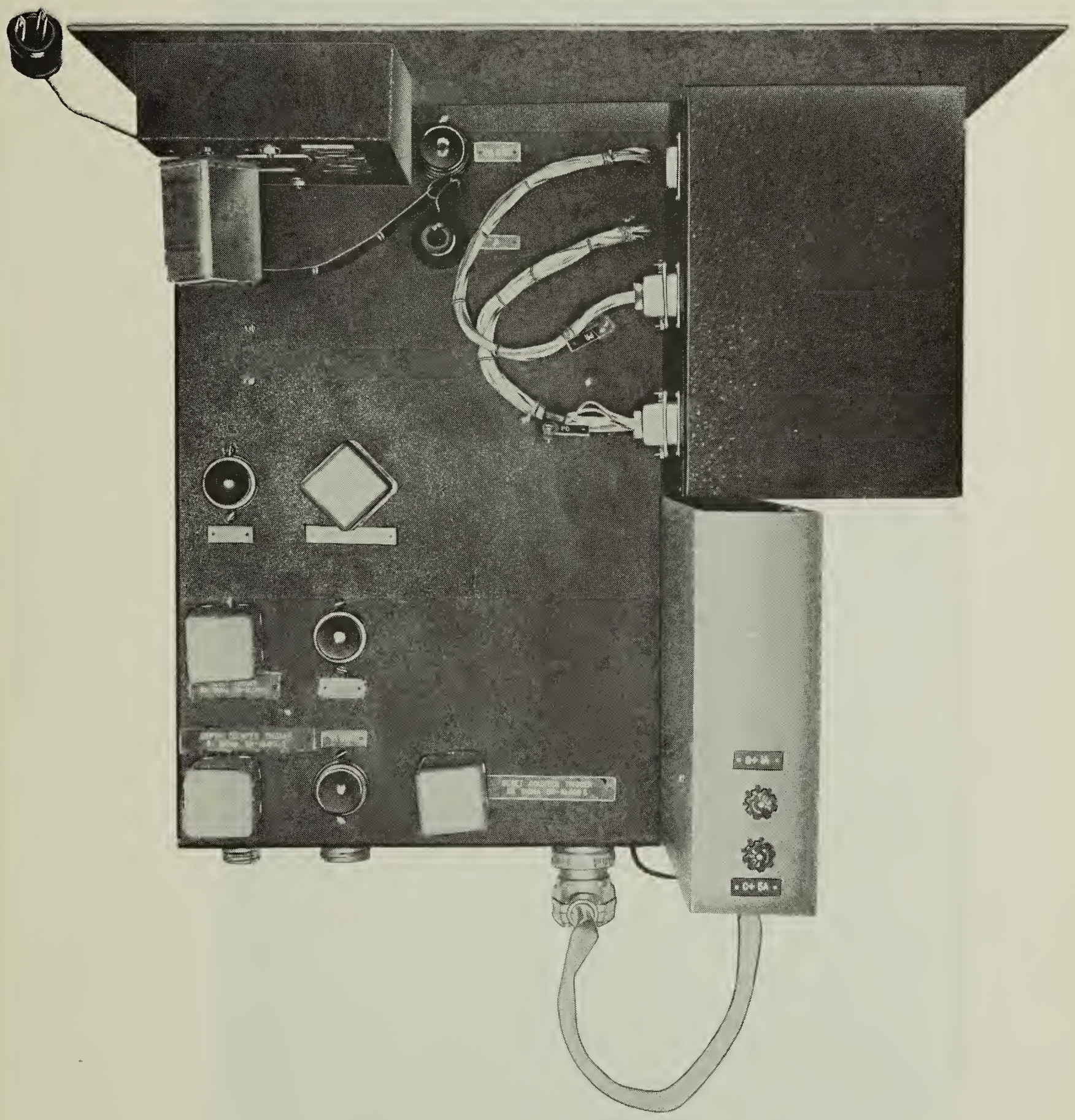

RECORDER CHASSIS FRONT PANEL

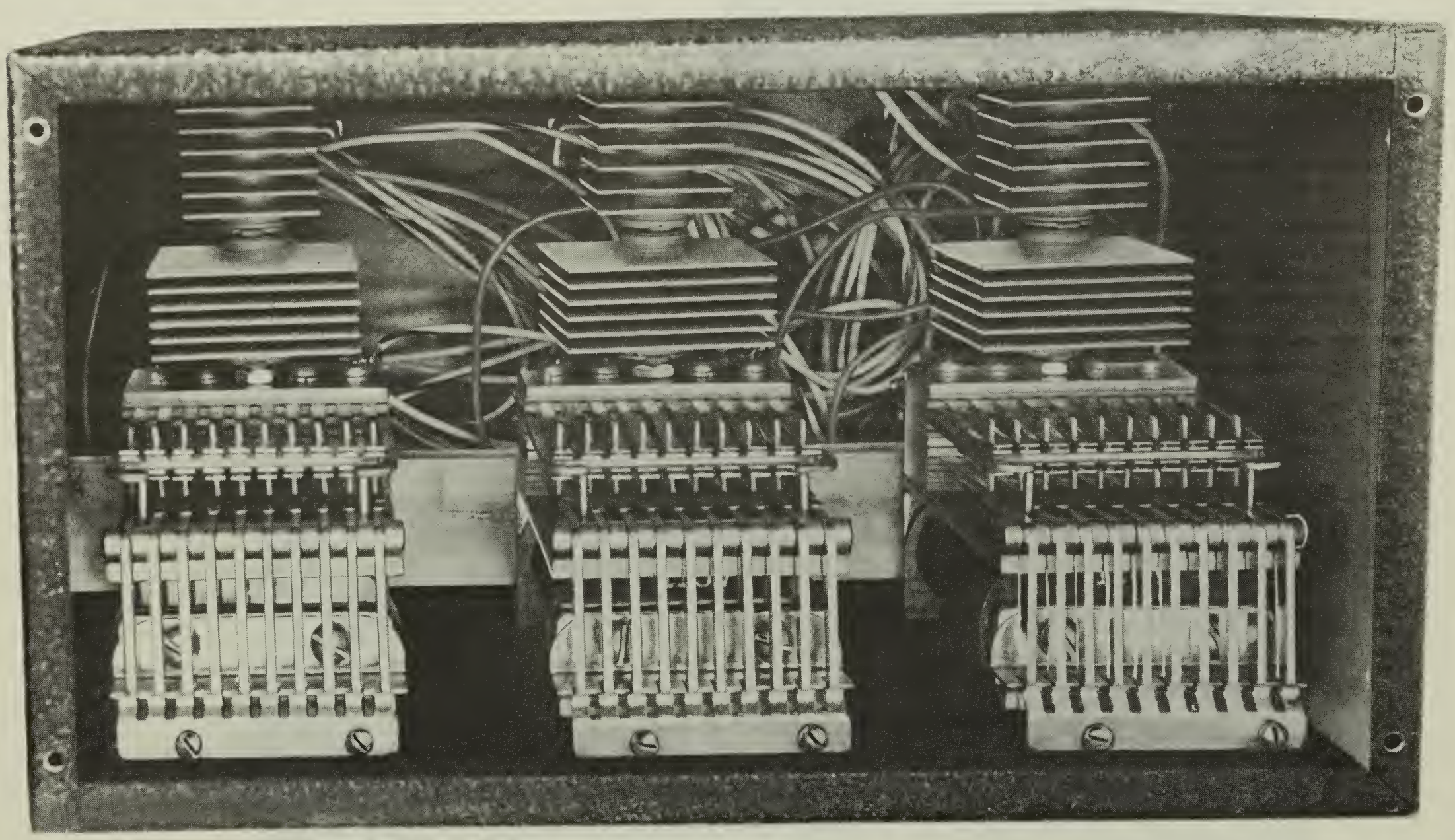



CONTROL UNIT

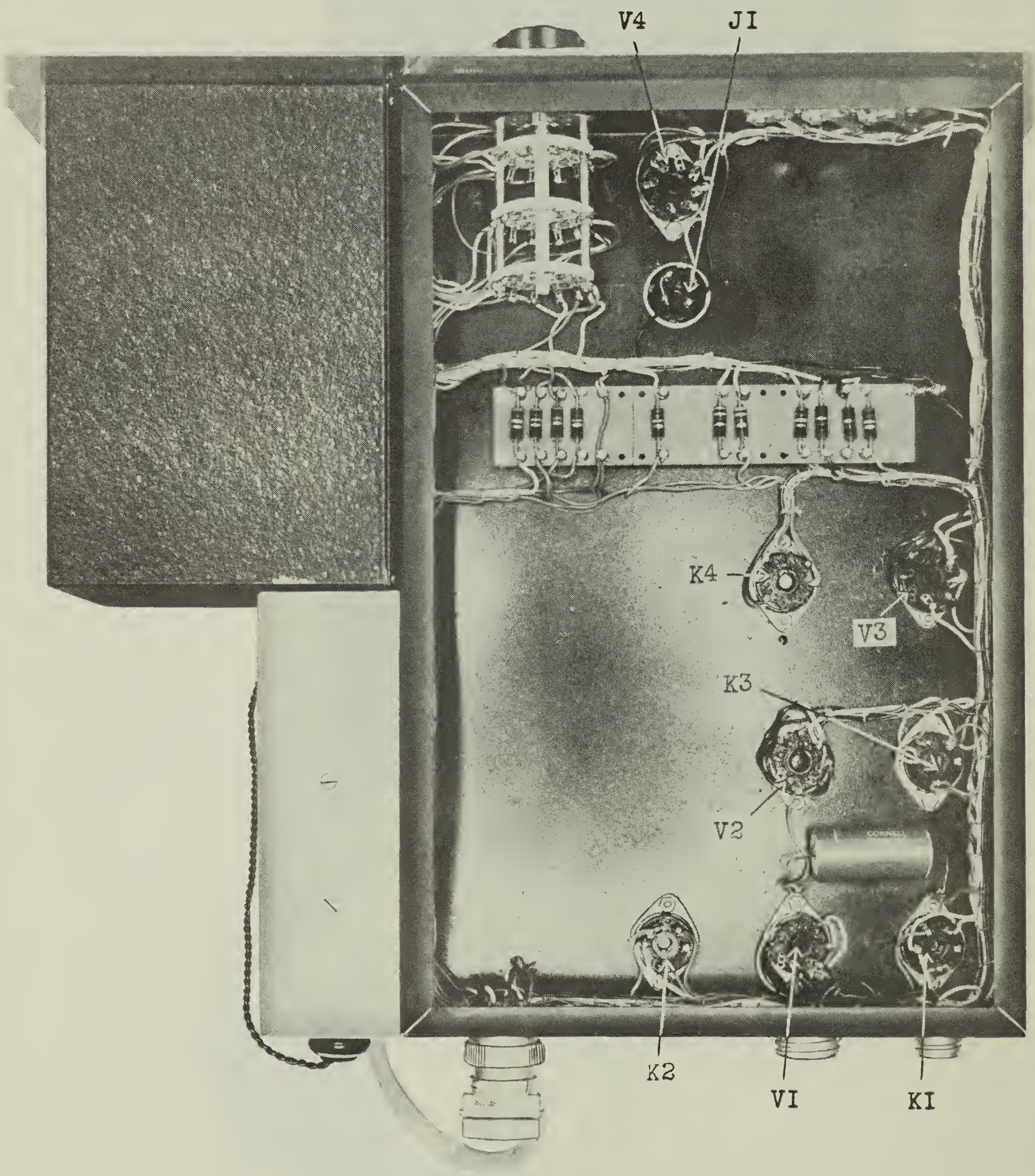



POWER SUPPLY CHASSIS

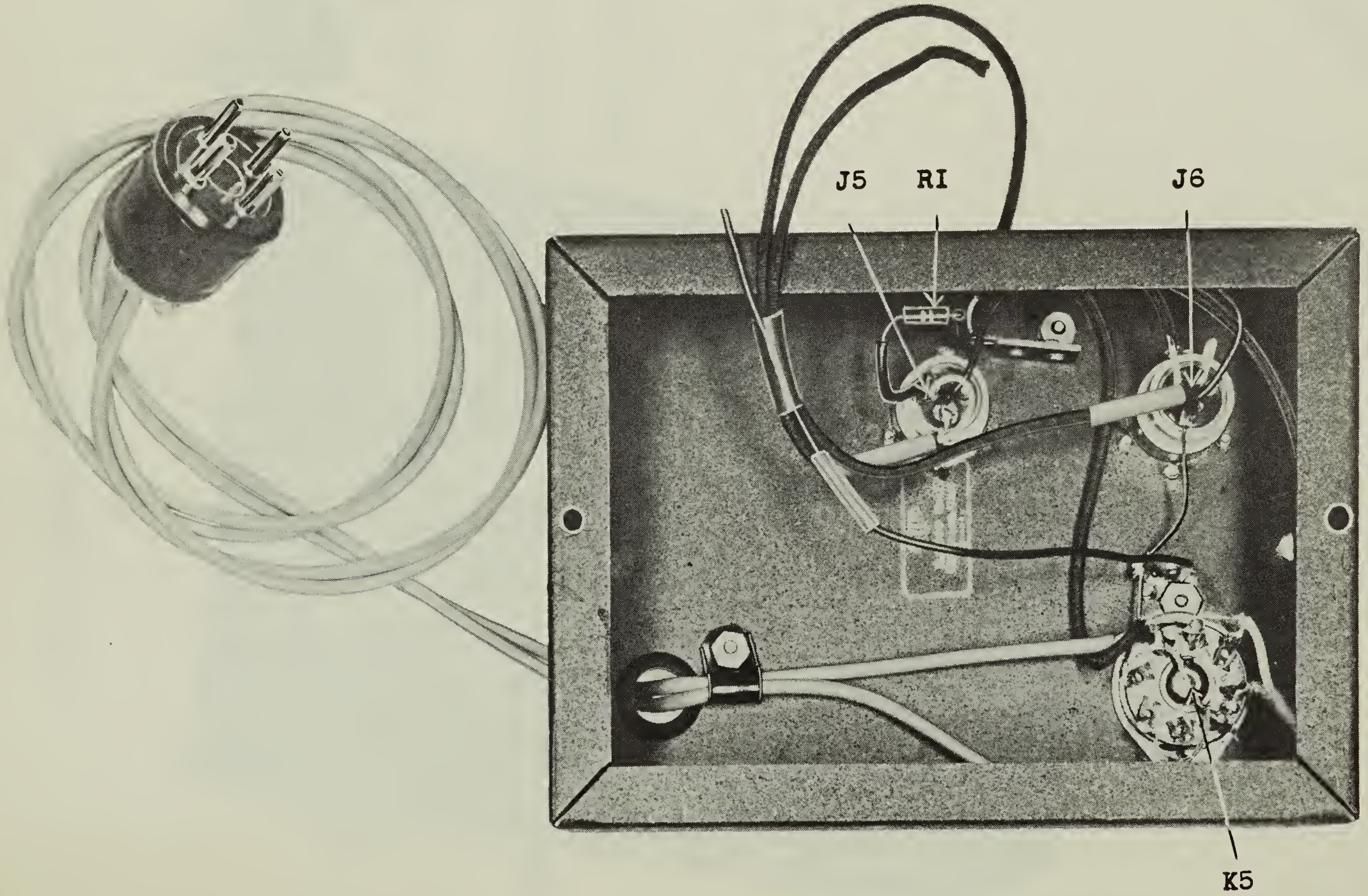




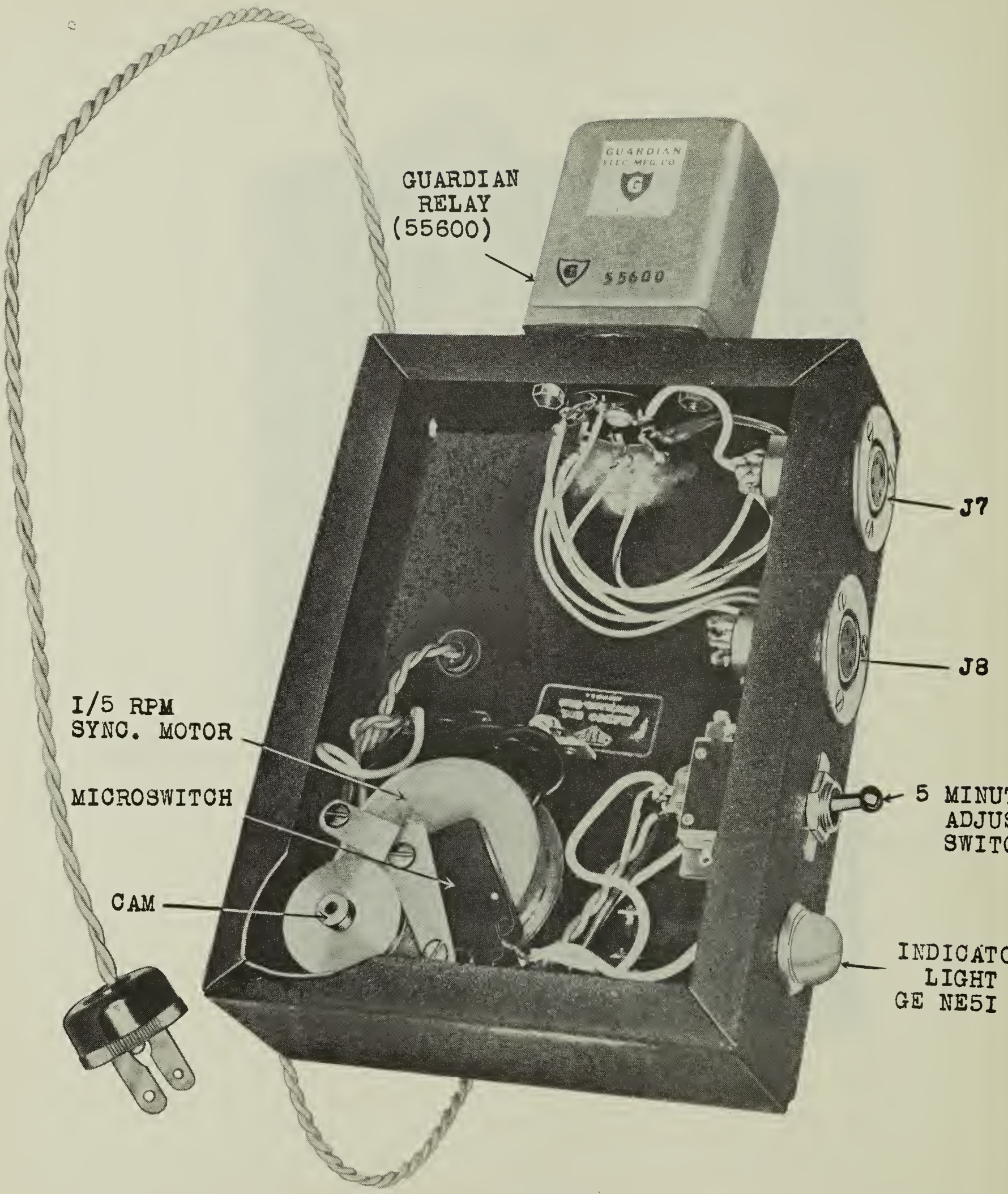
COUNTER CHASSIS




CONTROL CHASSIS BOTTOM VIEW

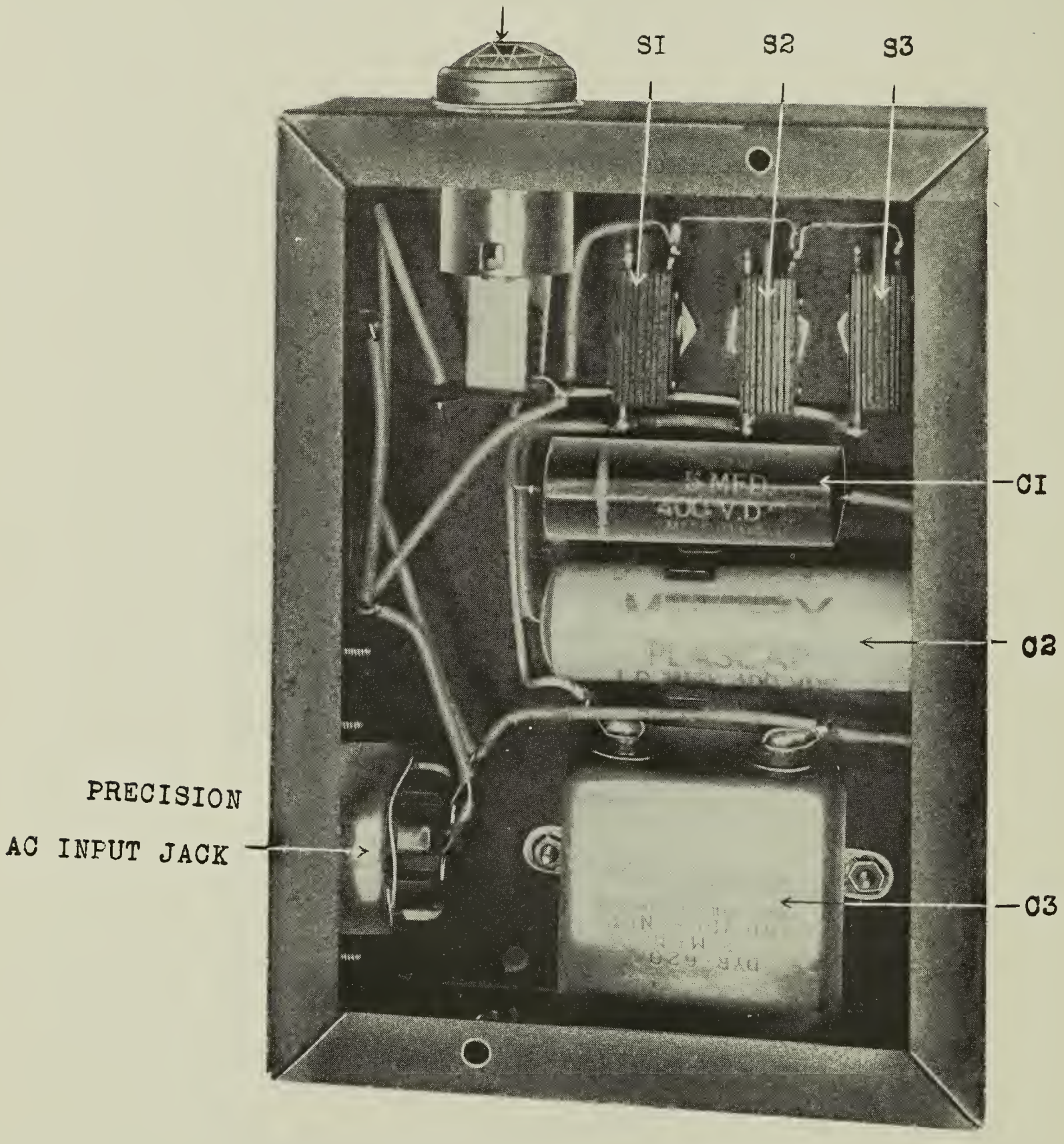



SIGNAL CHASSIS




20 FATHOM MARK INTERRUPTER CHASSIS

Fig. 19




PRECISION AC LOADING CHASSIS

Fig. 20

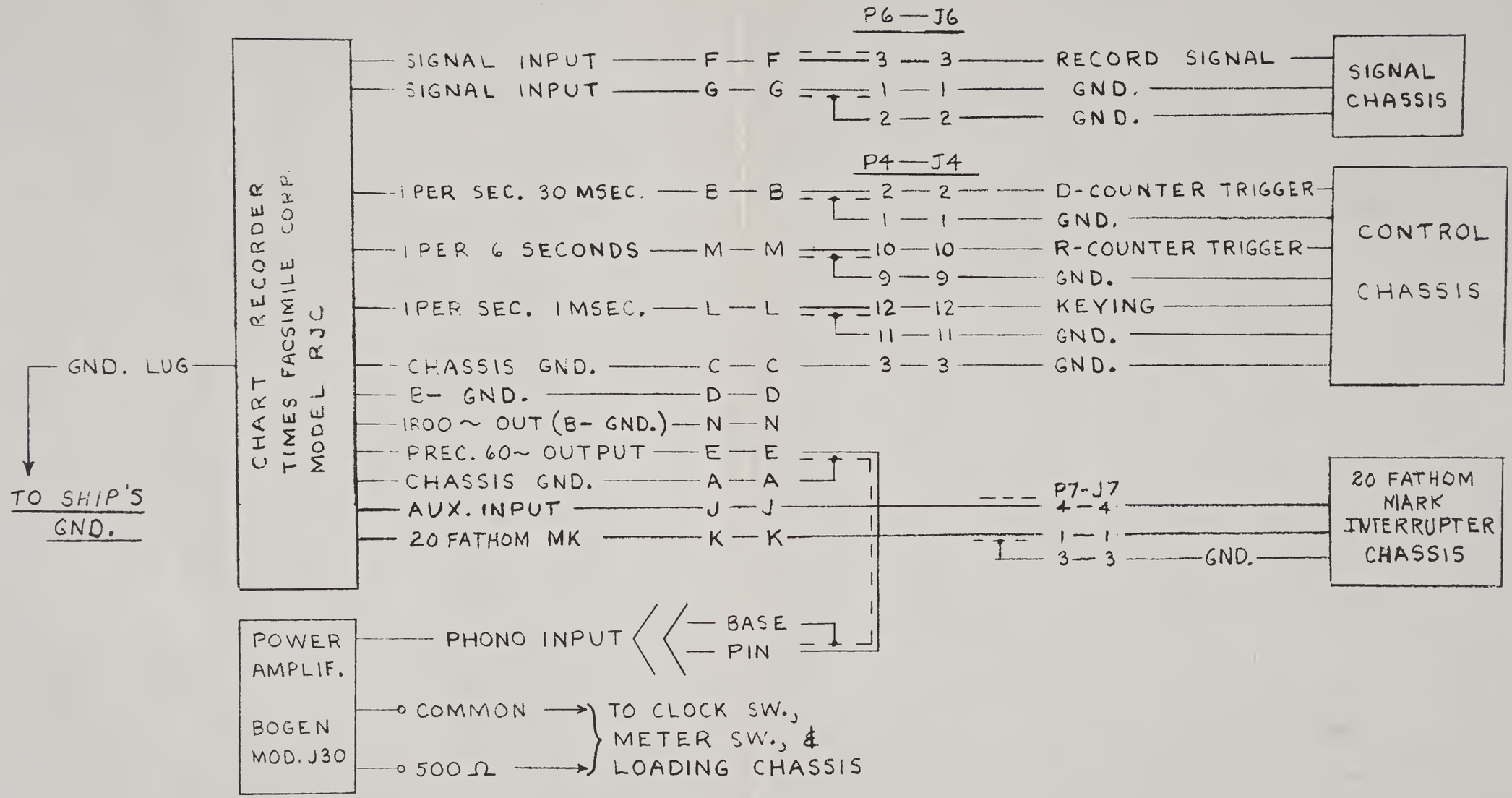



FIGURE 21

RECORDER CABLE

PDR MK IV-A

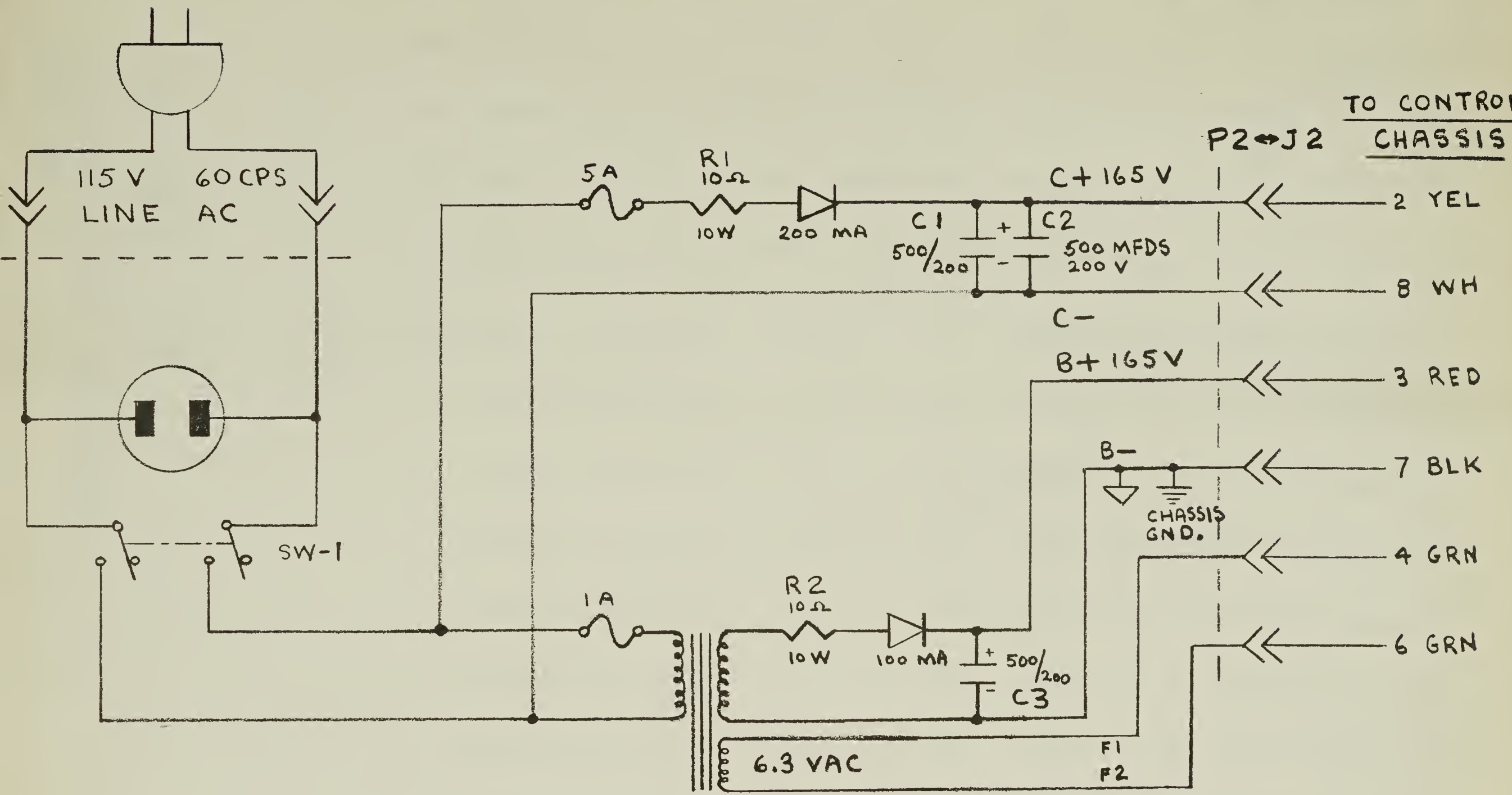
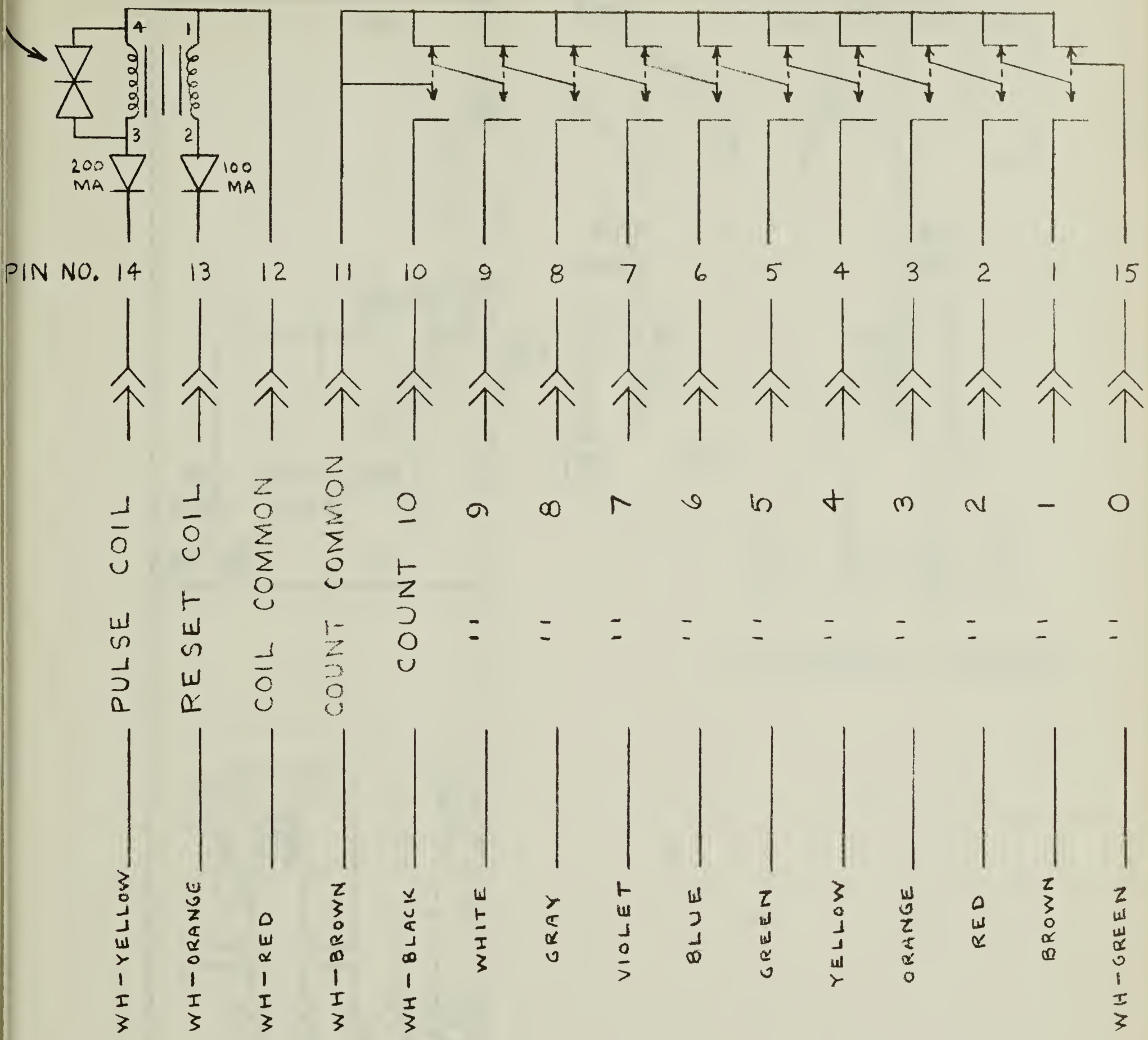


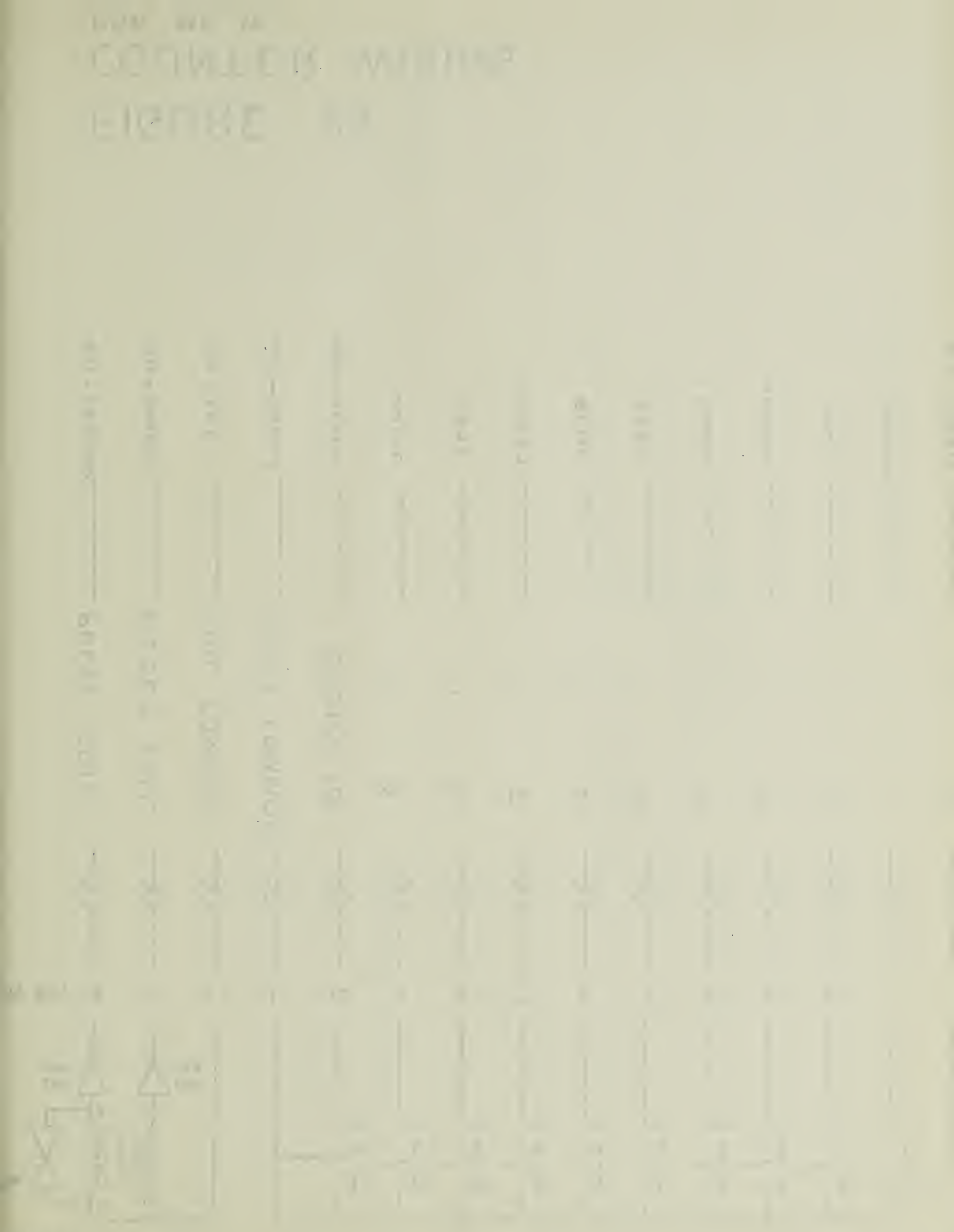

FIGURE 22

POWER SUPPLY

PDR MK IV




# FIGURE 23
# COUNTER WIRING
PDR MK IV



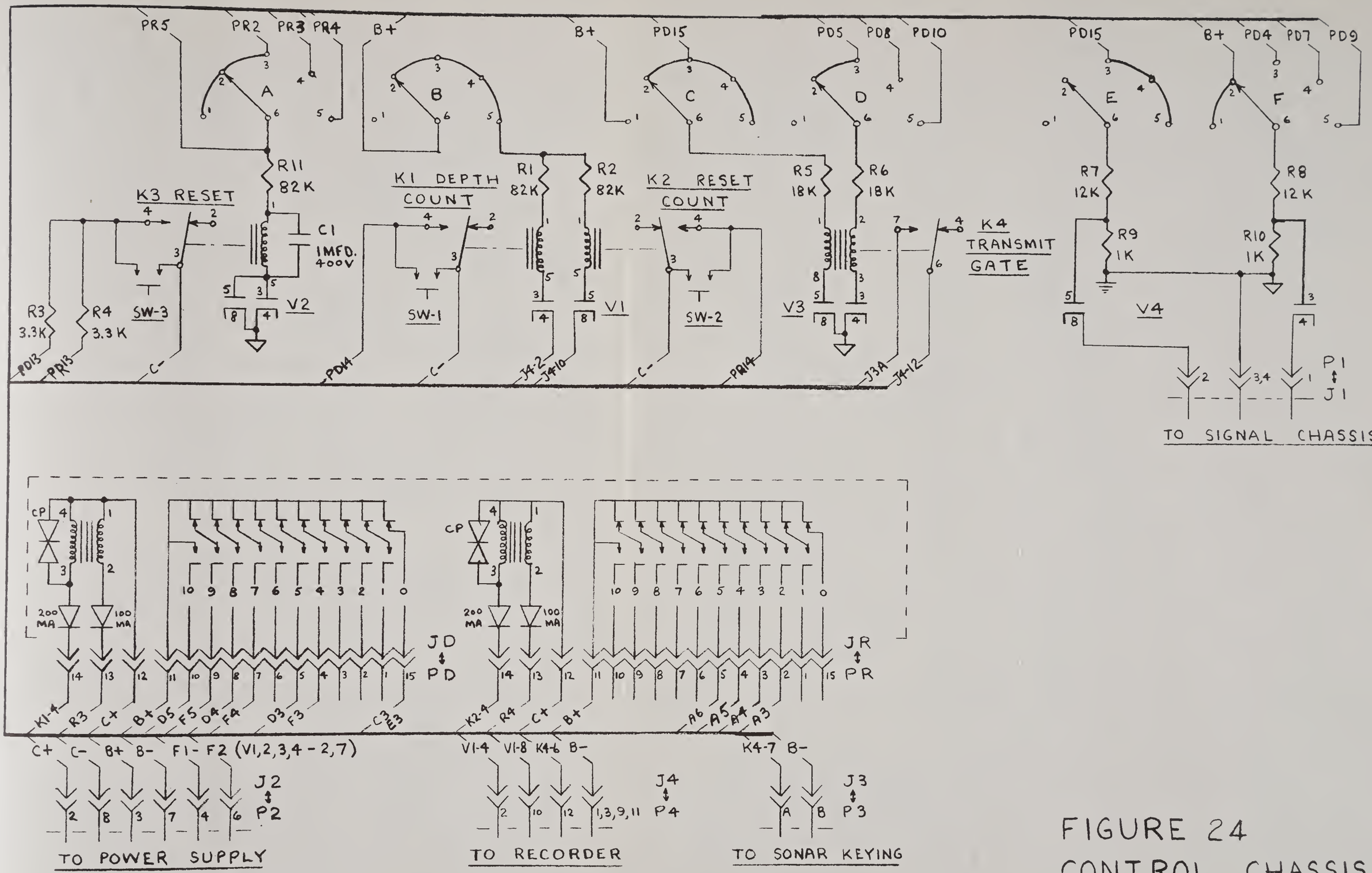
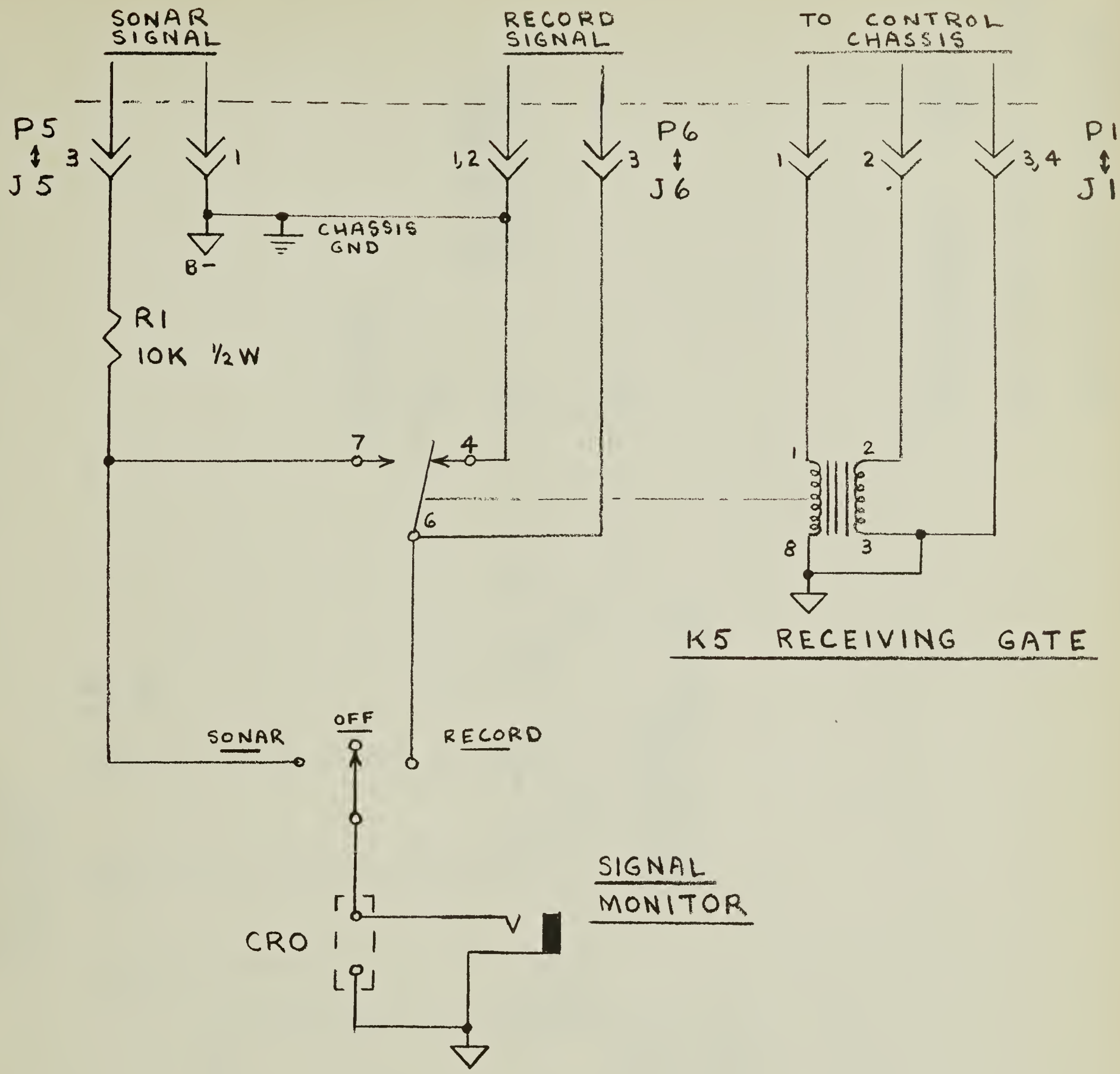



FIGURE 24
CONTROL CHASSIS
PDR MK IV-A




# FIGURE 25

# SIGNAL CHASSIS

PDR MK IV-A

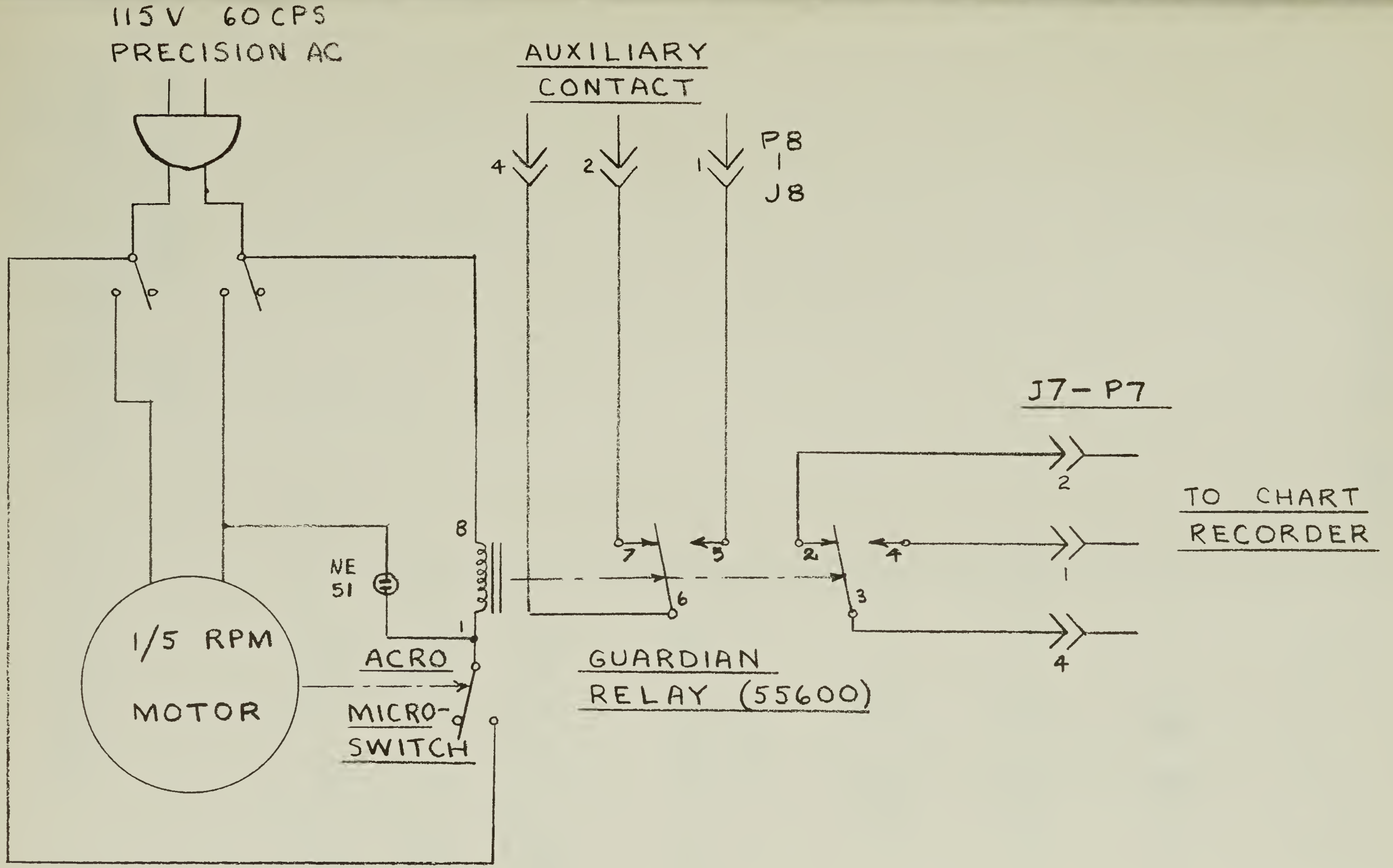



FIGURE 26
20 FATHOM MARK
INTERRUPTER

PDR MK IV-A

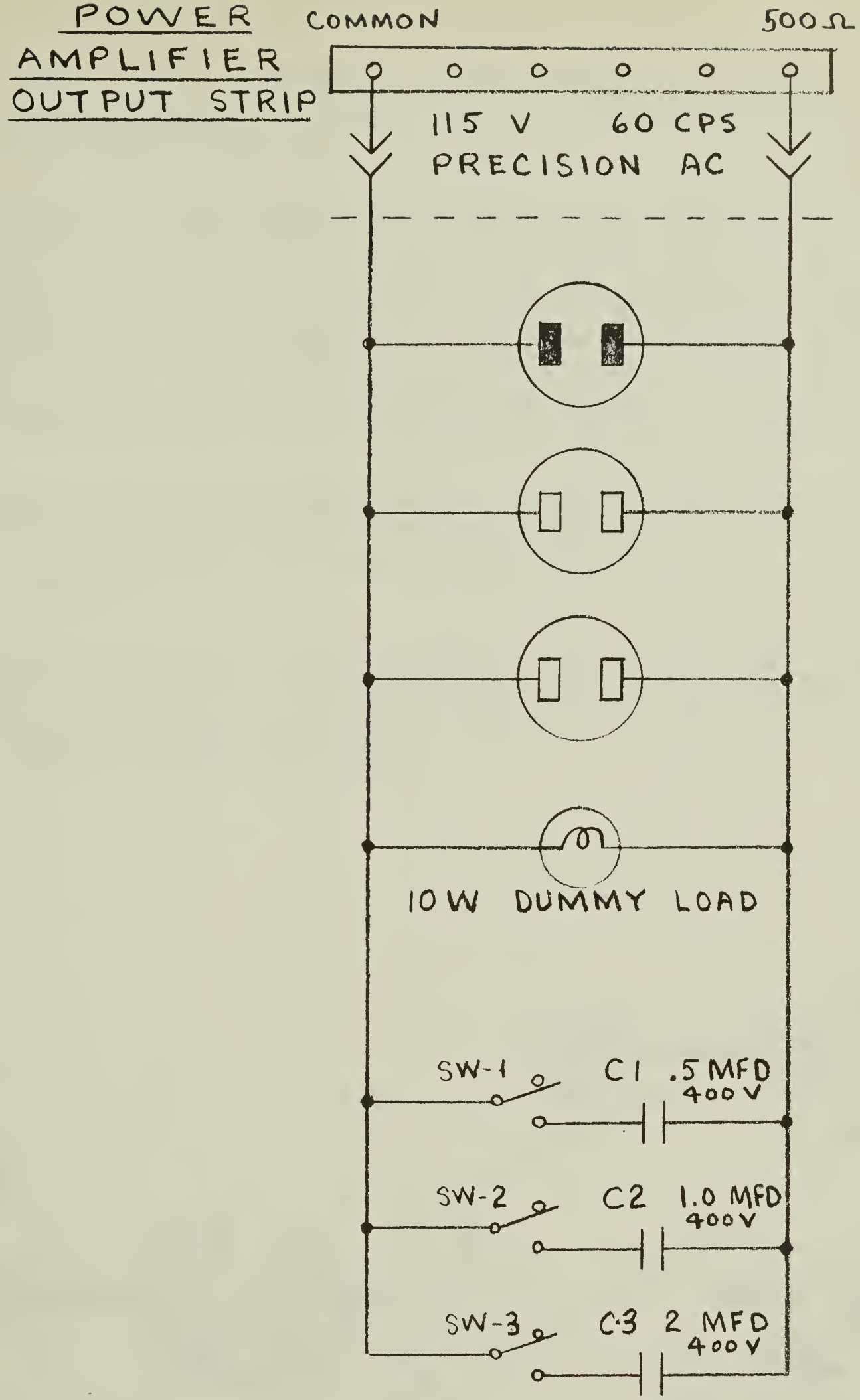



FIGURE 27

PRECISION AC LOADING CHASSIS

PDR MK IV

In Fig. 2 which shows the Mechanical drive assembly, the band 1 carrying the stylus holders 2 is driven by the non-synchronous run motor 3 through the reduction gears.

The stylus holders 2 have lug projections that catch on the holdback arm 5 which cannot be pulled above synchronous speed (see Fig. 3). The wheel 18 rotates freely about the shaft 19. The shaft 19 of the holdback arm 5 drives the collar 6 upon which is attached the drive dog 7. The run motor 3 tends to drive the system above synchronous speed, thus causing the drive dog 7 to rotate until it engages the latch 8 mounted on the collar 9. The collar 9 is geared to the synchronous motor so as to run at synchronous speed. The drive back to the synchronous motor is through the gear 17.

When starting up the system preparatory to recording, the synchronous motor 13 is first brought up to speed by the start motor 14. There is no load on the synchronous motor because the latch 8 trips over the drive dog 7 which is not rotating.

When the run motor 3 starts up, it speeds up until the drive dog 7 catches up with the latch 8. The band 1 is then held down to synchronous speed. When the run motor stops the synchronous system between motor 13 and latch 8 continues to rotate at synchronous speed.

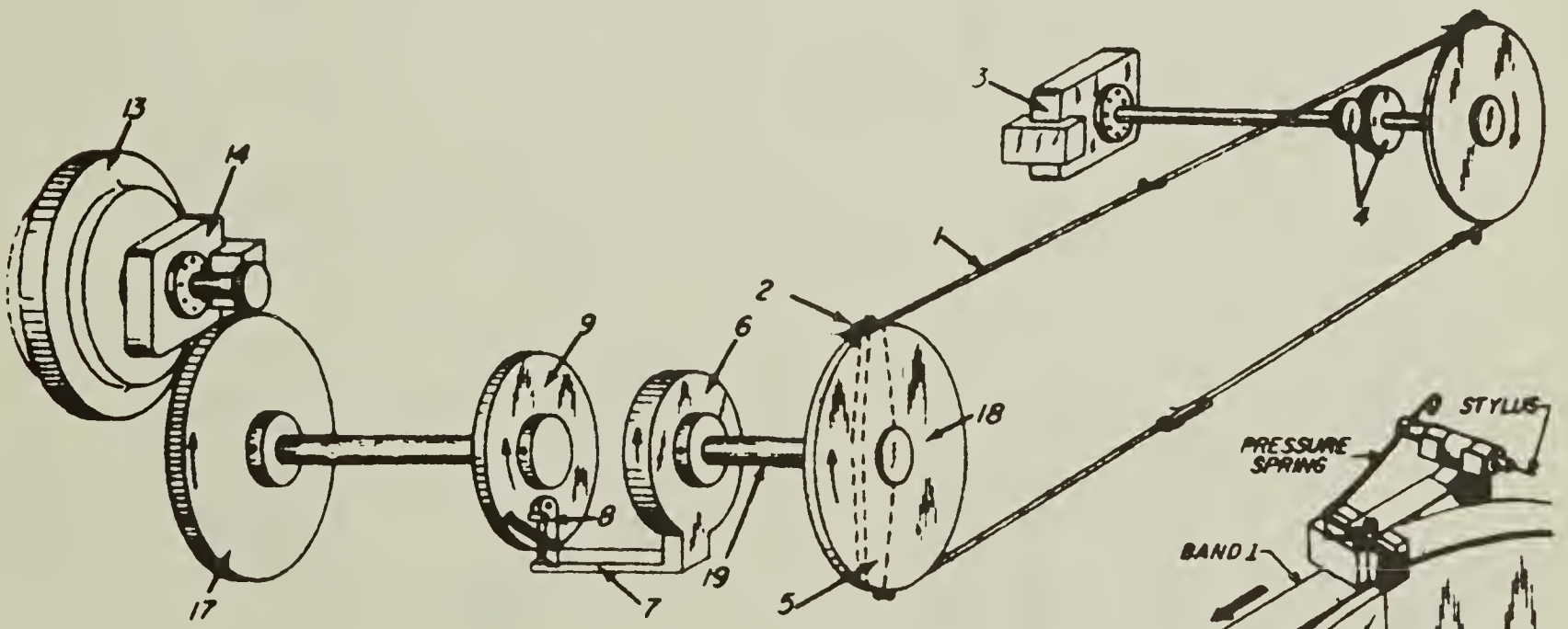



*Fig. 2. Synchronous Drive System*




*Fig. 3. Recorder Stylus and Drive Lug Assembly.*

FIGURE 28

HIGH IMPEDANCE SHORTING PLUG

NOTE:—RECEPTACLE ON AMPLIFIER CHASSIS IS CANNON XL-3-14. MATCHING MICROPHONE PLUG IS CANNON XL-3-11.

ISSUE REVISION BY

6SF5 6SF5 6SL7GT 6L6G 6L6G

MIC. 1 PHONO INPUT

.047 .033 .00082 .1 .22MEG 4.7MEG 110V 135V 150V 435V 330V 27V 1.8V 1V

2.2MEG. .22MEG. .5MEG. V202C .22MEG. 1500 .047 .22MEG. 1.5MEG. V129E 8ASS .0033 V202C .5MEG. TREBLE 2200 .22MEG. .15MEG. 8200 33-1W 200-7W 50 .47MEG V202C .5 MEG .47 MEG 33K 10

T261 OUTPUT STRIP 500~ 250-164~ 16~ 8~ 4~ COMMON FLEXIBLE LEAD

SPEAKER SOCKETS

(VIEW FROM REAR OF AMPLIFIER)
CONNECT LUG ON FLEXIBLE LEAD TO OUTPUT STRIP FOR IMPEDANCE DESIRED AT SPEAKER SOCKETS.

S336 POWER SWITCH MDL 2A. T-365-1 450V 50-7W 440V 460V 1000-2W R23326 20K-16W 3K-10W .047

117 VOLTS 60~ 120WATTS A.C. RECEPTACLE

5U4G FIL. FIL.

LINE A.C. OFF PREC. A.C. LINE A.C. PREC. A.C.

SLATE VOLT METER P.F. Corr.

MICROPHONE CONNECTIONS

HIGH IMPEDANCE MICROPHONE

LOW IMPEDANCE MICROPHONE

T-155

NOTE: FOR 200 OHM MIC. USE T-155

NOTE: ALL CAPACITOR VALUES ARE IN MFD.

| | | | |
|---|---|---|---|
| TOLERANCES UNLESS OTHERWISE SPECIFIED | TITLE: SCHEMATIC MODEL J130 | DRAWN F.A. | DATE 6-30-54 |
| | | CHECKED — | JO J1088 |
| | | APPROVED J.B. | MODEL J130 |
| | | SCALE — | SHEET OF SHTS |
| DAVID BOGEN CO., INC. NEW YORK 14 N.Y. | | DRAWING NO. 1088-02 | ISSUE 1 |

FIGURE 29